BIENNIAL REPORT

OF THE

BOARD OF HEALTH

OF THE

STATE OF CALIFORNIA

1874—75.

Third Biennial Report

OF THE

STATE BOARD OF HEALTH

OF

CALIFORNIA,

FOR THE YEARS 1874 AND 1875.

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OF THE

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OF THE

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HENRY GIBBONS, Sr., M. D., President.....San Francisco.
* JAMES MURPHY, M. D.....San Francisco.
F. W. TODD, M. D.....Stockton.
A. B. STOUT, M. D.....San Francisco.
LUKE ROBINSON, M. D.....Colusa.
J. F. MONTGOMERY, M. D.....Sacramento.
THOMAS M. LOGAN, M. D., Secretary State Board of Health.....Sacramento.

STANDING COMMITTEES.

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On Intoxicating Liquors, Inebriate Asylums, Pathological Influence of Alcohol, etc.—Dr. H. GIBBONS, Dr. JAMES MURPHY, and Dr. J. F. MONTGOMERY.

Of these different committees, the Secretary is made, by resolution of the Board, a member, as well as *ex officio* the Executive of the Board.

* Dr. Murphy was commissioned by Governor Pacheco, on the fifteenth of March, eighteen hundred and seventy-five, to supply the place of Dr. Lane, absent in Europe.

GENERAL REPORT TO THE GOVERNOR.

OFFICE OF STATE BOARD OF HEALTH,
SACRAMENTO (Cal.), July 1st, 1875.

To His Excellency,
ROMUALDO PACHECO,
Governor of California:

GOVERNOR: In compliance with the requirements of the law establishing a State Board of Health, I have the honor to submit the accompanying report. While performing this official act, permit me to tender my congratulations on the steady advance of the State in public health, which is public wealth. This is attested by the constantly diminishing low death-rate, as seen in the chapter of mortality statistics, and which has already given to California the title of the "Sanitarium of the World."

Without pretending that anything more than a good commencement has been made in our organized efforts to search out the most important causes of disease and death, in order that they may be avoided, there is yet reason to believe that the direction of the public mind to sanitary measures, through the mere fact of the creation of a State Board of Health, and the dissemination, by these biennial reports, of hygienic knowledge, has already prevented, and will continue to prevent, in some degree, the unnecessary waste of life.

It is only now that we are beginning to realize how vast a proportion of both our illnesses and deaths are due to purely and easily preventable causes, and the knowledge has hardly yet fairly started us into action. And this remark applies not to California alone, but to every part of the civilized world.

Look at London, with her reconstructed sewerage. What originated and put into operation this colossal achievement of sanitary engineering, but the awakened consciousness that thousands, nay, more than a hundred thousand of deaths, could be annually traced to zymotic diseases, generated and propagated by filth, noxious gases, tainted water, and the like—all of which factors of disease might be extinguished or neutralized by the prompt and energetic administration of well known sanitary laws.

Apart from the sickness and mortality arising from the material causes, just mentioned, there is a vast amount of preventable disease attributable to social causes, which legislative measures, or sanitary precautions, do not reach. So far as these causes are concerned, the

hopes of progress and improvement in California, as already stated, must rest, for the present, on education, wide-spread and general. The fundamental principles of domestic as well as public hygiene must become matters of intelligent conviction amongst all classes, and especially amongst the wealthier classes, that they may help those of the poorer, who are unable to help themselves. If, for instance, unwholesome overcrowding were prevented by an adequate supply of comfortable dwellings for the poor, and if all those dwellings were well drained and ventilated, and furnished with an ample supply of good water, not only might many preventable diseases become controlled, but a number of other evils, now acting and reacting on each other, would be eliminated or greatly mitigated. Each valuable influence, put into operation, is a potent ally of every other, and this is the most encouraging feature of what we are now considering; amendment and reform, in one point, brings amendment and progress in all others. We cannot improve the surroundings of the depraved without, *pro tanto*, raising the moral feelings, and lessening that craving for stupefying strong drink, created and stimulated by breathing fœtid air. We cannot, without the universal establishment of wholesome and decent homes for the poor, minimize the premature deaths caused by the want of such, or vivify the possible sapped health and strength of thousands yet unborn.

It generally happens, whenever such sanitary questions as these are raised, that "education" is pronounced in a dogmatic and unreasonable way, in connection with schools, as the remedy. Now, education is the business of home; instruction is the work of the schools. It is at home that the feelings, affections, habits, and aspirations which govern the conduct of the future life, are matured; and the happiness or misery, the success or failure of the man, depends upon the training of the child. What can be expected of the neglected, street-running child, when ripened into the full fledged vagabond? Long ago Guizot said: "Home is the domestic country of the man," and he pointed to the cultivation of the family ties as essential to the growth of true patriotism. The President of the British Social Science Association declared, in eighteen hundred and sixty-six, his belief, that in order "to improve the moral condition of the people, we must improve their domiciliary condition; and in doing so, we should destroy their appetite for spirituous liquors." Intoxication was almost forced upon the people by the depressing influence of the localities in which they lived. Having gone for hours together through filthy localities, he could assert from experience that the atmospheric influences, the sights, and the smells he exposed himself to, produced such a weakness and faintness that he would have given anything for a glass of spirits to sustain his sinking nature. If that were the case with himself, who was generally well fed and in good health, what must be the case with those who live in such places perpetually?

There are, it is feared, multitudes in all our large towns so heavily burdened with the load of a vitiated heritage, and so hemmed in by the barriers of foul air, filth, and want, that teaching and preaching can only be felt as bitter mockeries, unless these barriers are first removed. Therein lie the duties of sanitary authorities, and only in compulsory measures is there any reasonable hope that amelioration and enlightenment may penetrate to these depths.

Allowing even a large estimate for the alleviation of preventable diseases, subjected to our present sanatory administration, still it is to be apprehended that the waste of life would, nevertheless, remain as

needless as it is appalling. What is wanted under these circumstances is power—coercive power, delegated under legislative restrictions, and exercised solely for the improvement of the public health.

SANATORY LAWS MUST BE ENFORCED.

In this country sanatory laws, to a certain extent, are permissive. In most of our cities and towns we find but little effort made to remedy the state of neglect, still existing in ill-ventilated buildings, and undrained and ill-drained localities. The local authorities, to whom are referred the execution of measures recommended by our Boards of Health, are not always imbued with the true spirit of humanity. Money considerations are with them often of greater importance than the question of life and death, and they too often overlook the hard fact, that while they remain inactive, disease and death do not.

Take San Francisco for example. With the full knowledge, derived from the experience of all the large cities in the world, of that most dangerous, if most natural of all tendencies in a productive and advancing country—the concentration of population into great towns, without any adequate effort to provide for it, or forestall its consequences—we are scarcely dreaming of the necessity of expanding our social garments, as our social body is outgrowing them. The same municipal government, or rather the same municipal makeshifts, which sufficed for San Francisco fifteen or twenty years ago, we seem to think will answer for the vast commercial mart of to-day. The same drainage system, the same sort of water supply, the same haphazard mode of multiplying buildings, which answered for a town of fifty thousand inhabitants, are being applied to the same town grown to two hundred and fifty thousand. To allow to perish by sanatory neglect is just the same as to take so many persons out of their homes, and forcibly put them to death; and yet, if this were done, the whole world would revolt at the barbarous act. Still, in how many instances do our local authorities calmly look on, while poor and innocent victims are condemned to breathe a poisoned atmosphere, or drink poisoned water, which is a great crime in the eyes of humanity. In view of the fact that this terrible continuing tax on human life, and all this needless suffering, fall with immense over-proportion upon the most helpless classes of society—upon the poor, the ignorant, the immature; upon classes which, because of their dependent position, cannot utter their indignant protest against the miseries thus permitted to be brought upon them—they have, from these circumstances, the strongest of all claims on a Legislature which can justly measure and can abate their grievances.

A LEGISLATIVE COMMITTEE ON PUBLIC HEALTH.

Our Legislature always has various committees, consisting of men selected for their special intelligence, to watch over the several classes of public interest and see that they suffer no damage; and more than this, to see that they derive the most benefit from the wisdom, care, and power of the Government. There are Committees on Education, Agriculture, Manufactures, Insurance, Finance, Fisheries, Railroads, Mercantile Affairs, Hospitals, Asylums, and other matters of public interest. The Legislature of New York adds to these a Committee on Public Health. I would, therefore, respectfully suggest to your Excellency to recommend the raising of a joint committee of the Senate and Assem-

bly, to act in concert with the State Board of Health, in so modifying the laws relating to public hygiene that they may have their basis and potency in the well recognized principle: "*Salus populi suprema est lex.*" In as far as human life is more important than all financial interests, and even in the financial view the creative power of human force is more valuable than all created capital, the interests of the people should take precedence of all other provisions. Every law, grant, or privilege from the Legislature should have this invariable condition, that human health should in no manner or degree be impaired or vitiated thereby.

When the Legislature grants the right to dig a canal or ditch, or to build a dam for reservoirs to flow the land or irrigate, the grantee is properly held responsible for all the damage that may be caused thereby to other lands, crops, or mills. This is right and proper; but besides this, the grantee should be held responsible that no damage shall be caused to human life by the changes in the condition of the waters. This cannot be compensated by money.

In all cases where life and health are in question, the arm of the Government should be used with sufficient force to protect them. When a person tampers with human life by adulterating food, or knowingly offers to sell unwholesome articles of diet; when he adulterates milk with water, or other foreign matter, and thus deprives children and adults of their due nourishment, or impairs their stomachs with indigestible mixtures; when men thus selfishly jeopardize the health and sacrifice the lives of others for their own gain, the law should recognize this as a crime, and hold the offense amenable to the same punishment as robbery or manslaughter. Nor should it relax its stringency until the people are assured of safety whenever they purchase milk or other articles of diet.

I am aware how fully the laws represent the feelings and opinions of the people, and that, if the law is inefficient or unacted upon, it arises from a want of knowledge on the part of the people themselves. Not only does this ignorance tell upon the Legislature, but even if it were possible for the Legislature to provide all the conditions of a healthy existence, this object could not be obtained unless the people were sufficiently instructed to avail themselves of the rights thus conferred upon them. It would be in vain for the Legislature to enact a plan upon which houses shall be built to insure ventilation, unless the inhabitants of those houses understand the worth of fresh air. In vain would it be to bring an abundant supply of fresh water to our doors, if in our ignorance and indolence we refuse to use it. There must be intelligence both in the legislator and those for whom he legislates, if we are to take advantage of our present knowledge of the laws of life to secure us from disease and death. Such being the general ignorance, to postpone State action until the people become educated would be to neglect the State's noblest function, and to consign its inhabitants meanwhile to very great dangers.

LEGISLATION AGAINST QUACKERY.

There is one terrible evil, however, with which the profession of medicine has long had to cope, and against which I would now specially urge legislative action, inasmuch as the people appear ripe for the movement. I allude to the unrestricted quackery which now sits like a vampire upon the body politic, and which is never satisfied until the last drop of the blood of its victim is exhausted. To no body of scientific observers

are the effects of mal-administration of medicine made more painfully manifest than to medical men; but who, unfortunately, have always placed themselves in a wrong position whenever they have attempted to have laws enacted to protect the people against it.

The difficulty has arisen from a want of understanding, on the part of the community, that such laws are intended for their protection, and not for the profession. So long as the community were not disposed to properly interpret our intentions, there was nothing else to be done but to wait until they were sufficiently educated to appreciate our motives.

Practically speaking, I believe the time has come when there will be no difficulty in having suitable laws passed, inasmuch as the people themselves are already drawing the line between quackery and legitimate medicine, and will take the proper steps to punish any offenders. Under this conviction, I have, as Chairman of a Committee on State Medicine and Public Hygiene, appointed by our State Medical Society, prepared the draft of an Act for presentation to our Legislature, looking to the protection of the sanitary interests of the people against fraud and imposture in the practice of medicine. This bill, after receiving the indorsement of the State Medical Society, has been submitted to the revision of a special committee, appointed for the purpose, and will be found in the pages of this document, together with the report of the Committee on State Medicine and Public Hygiene.

THE WORK OF THE BOARD.

In accordance with the plan of duties adopted by the Board, information and advice connected with public hygiene have been prepared and disseminated, from time to time, otherwise than through our biennial reports. Lectures have been delivered, particularly in our university, and in some of our seminaries and schools, calculated to educate the rising generation to a due appreciation of the laws of health.

The daily press has rendered much good aid in giving publicity to our instructions as to preventive measures against scarlatina, small-pox, malarial fevers, and other preventable diseases; likewise in calling attention to our recommendations relating to draining and filling in of low, swampy places; and also in fostering the cultivation of grasses and trees, especially of the eucalyptus species. These publications, although fragmentary and unofficial, have done much to spread the knowledge of hygienic principles, by chronicling successful results, and by showing up, in its true light, the sanitary condition of various localities; in giving warning of surrounding danger; in advising as to the steps to be taken; generally, in the elucidation of truth and eradication of error; and, finally, in the encouragement invariably imparted to the advancement and prosecution of sanitary science.

Besides the means already mentioned for carrying out the object of the Board, an extensive correspondence has been continuously kept up with the medical men scattered in all directions over the wide area of the State, who, as a rule, have acted like true philanthropists, in generally responding promptly to all questions relating to sickness and disease. The names of most of these voluntary coöperators will be found in connection with the mortality reports, from some forty cities and towns, published monthly in the "Pacific Medical and Surgical Journal," and the "Western Lancet," of San Francisco, abstracts from which will be found in this report. The true sanitary condition of the State is thus ascertained from reliable sources, and the results made

known in an authoritative manner, for the benefit both of the profession and the community, together with such remarks relating to prevailing diseases as the state of the case seems at the time to require.

The regular meetings of the Board have been much occupied with the discussion of the information derived from these mortality reports, and several important subjects connected therewith, that have as yet not been published otherwise, have received attention through newspaper reports of the meetings. Furthermore, for the more complete fulfillment of all the purposes for which the State Board of Health was created, the different members have charged themselves with the investigation of special questions germane to the functions of their office, the character and scope of which will be learned from the titles and synopsis of their contents, and to which, now published in the order they were read and considered, I most respectfully beg leave to call attention.

VITAL STATISTICS.

The peremptory requirements of the Board, immediately after its initiatory organization, devolved upon me, as its executive officer, the necessity of devising some general plan in accordance with the methods that the principles of sanitary science have already established, for the purpose of determining the real condition of the State as regards the relative fecundity and mortality of her population, the causes of death within her borders, and the weight with which each cause of death presses upon different portions of the community, whether those portions be considered in relation to age, sex, or condition of her people, or in relation to different sections of her territory.

To meet the emergency, I gratuitously assumed the additional duties of the office of Registrar of Births, Marriages, and Deaths—an office altogether extraneous to that which I hold (Permanent Secretary of this Board), and which, as is well known, is confided in our sister States to a distinct and separate bureau.

These additional duties have involved an extraordinary amount of correspondence and travel, which has kept me continually occupied in the discharge of the self-imposed functions of two distinct offices, either of which exacts, for its proper execution, constant and unremittent application. Onerous, however, as these duties have been, they would be regarded matters of gratulation, had the results been such as were expected to be accomplished. As it has turned out, the law, although simple and apparently easy of execution, has not been generally complied with, in consequence chiefly of some intrinsic defects in its framing and the resulting misunderstandings that have arisen respecting its details and workings. Accordingly the returns that have been received from such counties as have complied with its conditions, are too incomplete to be made available for the purposes for which they were designed. This is only what might have been expected, and which has been the experience of every nation and State in the inauguration of such registration.

"In its practical application to communities, sanitary science in this, as in every other particular, has the same difficulties to overcome here as it has encountered everywhere. Restrictions in long established habits of life and business are submitted to slowly and with much reluctance. Personal convenience rises in antagonism to the principle which requires each member of society to yield something of individual comfort for the general good. The people require to be educated to such

necessity, and the importance of the sacrifice of their own convenience or personal interest. They are to learn that the record proof of the birth, marriage, or death of any person, or of all persons, may become of great importance from a legal standpoint; that the statistics derived therefrom furnish a sure index to the prosperity of the State in the number of births and marriages; that they supply data upon which governments, communities, and life insurancers may base their action; and that they furnish knowledge of unfavorable locations and conditions, which, when known, may be avoided, and the struggle for life thereby rendered easier and more certain of success."

Had the last Legislature approved the amendments of the public health laws suggested in our second biennial report, from which the above extract is made, we would, perhaps, now be deriving the benefits therein enumerated; or, at all events, we would have learned something more as to the working of the machinery of the registration laws—the defects of which, it was contemplated, would thus, in some degree at least, be remedied. Owing, however, to the indifference manifested towards the great social questions involved in these laws, their execution has become so nugatory, that I despair of ever making them available for statistical purposes, in their present shape. I would, therefore, respectfully recommend, after the renewed experience I have had of their practical operation, during the last two years, that they be placed, as in other States, under the special management of the Secretary of State. Their proper administration exacts more authoritative powers than are possessed by the State Board of Health, involving an expenditure for clerical labors, and the furnishing of blank books and forms of returns, with proper rulings and headings, to County Clerks and others, not otherwise provided for. The lack of provision for carrying into effect the law in these latter respects, was probably the principal reason why it has not been more generally obeyed.

It will be observed, notwithstanding, that pursuing the plan adopted in our preceding biennial reports, I have been enabled to present the mortality statistics derived from the continuous reports of numerous cities and towns, situated in every section of the State, and embracing about half the total population. These results, together with those obtained from the reports of the various hospitals and public charitable institutions in the State, show a very favorable sanatory condition, and will be found under their appropriate headings.

IRRIGATION.

This subject, of such momentous import to the industrial interests of the State, has not failed to receive the special consideration to which it is entitled from a sanatory point of view. In another part of this report, in the paper under the head of Malarial Fevers and Consumption, the fact will be found well established that the spreading of water over the surface bears a strong causative relation to malaria. This is proven not only by the history of irrigation thus far in our own State and elsewhere in the development of diseases attributed to malaria; but, also, *e converso*, by the disappearance of the effects of the latter, when overflowed marsh and swamp lands are properly drained and cultivated. Such favorable results are partly due to the systematic removal of the

surface water, and partly to the absorption of the decomposing organic matter by the growing crops. On the same principle, Maury succeeded in modifying, if not in preventing the malignant fevers that originated in the marshes surrounding the observatory at Washington, by an extensive planting of the *helianthus*, or sunflower, which possesses an uncommonly great absorbing power.

To the influence of a large flowering aquatic plant (*Jussieua grandiflora*), Cartwright ascribed the immunity from fevers of the bayous and lagoons in lower Louisiana; and Sebastian recommends, for similar reasons, the culture of the calamus (*acorus calamus aromaticus*). For the same purpose, we have, particularly on account of its rapid growth, and the balsamic exhalation of its etherial oil, suggested and encouraged a general planting of the *eucalyptus globulus*.

By such means, in conjunction with systematic and thrifty culture of the soil, and the careful handling of all products, it is confidently expected, that we will not only be enabled to ward off disease, but also to enhance the salubrity of certain localities now regarded as notoriously unhealthy. Everything, however, depends upon the judgment and skill exercised by the engineers, who must design, plan, and execute the necessary works. After a thorough reconnaissance shall have been made, and a knowledge of the experience of other countries practically applied, a comprehensive system of irrigation may be intelligently carried out, and the great valley divided into those natural districts which its topographical features might be found to require for the attainment of all the ends contemplated, in conformity with the well defined laws of sanatory science. To the map, demonstrative of some of the main features of a projected system of irrigation, as well as the range of malarial diseases, in connection with temperature, I would respectfully refer for further information on this subject.

SEWERAGE AND DRAINAGE.

There is no subject within the scope of our official duties which may be regarded as of more vital importance than that of sewerage and drainage. Upon the character and perfection of the appliances within our cities and towns for the removal of decomposing matter, the success of all sanitary efforts is more dependent than upon salubrity or insalubrity of climate.

For example, Paris and Brussels, which have climates more salubrious than that of London, have nevertheless a higher rate of mortality than the latter, proving conclusively that the sanitary works of London are of a more effectual, and therefore of a more perfect character, and that they better fulfill their mission, than those either in Brussels or Paris.

Notwithstanding the teachings of history, showing on the one hand that the frightful pestilences of the middle ages were owing to the saturation of the ground and pollution of the streams with filth, and on the other, that to the drainage of ancient Rome, which was arranged upon principles deduced from the most profound study of mathematics and hydraulics, may be attributed the success with which the inhabitants of the Imperial City preserved social order throughout so dense and vast a mass of human beings, it is only within forty years of our present civilization that the abominable cesspool system began to be superseded by the sewerage system.

Before the present century vast quantities of filth were allowed to

accumulate in tanks or pits, termed *cesspools*, in the best ordered cities of the world; and whenever the amount of refuse exceeded certain limits it was removed by manual or horse labor, and thrown into the rivers. It can easily be imagined what a bad effect these accumulations of putrifying animal and vegetable matters must have produced upon the health of the inhabitants of cities. They poisoned the atmosphere with fœted emanations, whilst the overflow or leakage of the liquid contents furnished abundant contributions to the wells. There can be no question as to the great superiority of the sewerage system as against the cesspool plan; for in every town, where it has been adopted, the public health has been greatly improved. The medical officer of the Privy Council of England, in one of his late annual reports, gives a list of twenty-four English towns in which, owing to the adoption of the present sewerage system and the improvement of the water supplies, the death-rate has been diminished from five to fifty per cent. The sewerage system was found, however, to be open to one great objection: it converted a large number of rivers into mere sewers, and greatly injured the riparian fisheries Owing to the enormous amount of filth discharged into the Thames, and similarly situated rivers, their waters in many places became simply diluted sewage, from which noxious exhalations were constantly evolving. The same effects are experienced from the drains opening above the low tidal edge at San Francisco. The mouths of these sewers should be trapped; for wind and the rising tide readily force back their contents, which are very fœtid, especially as salt water promotes the decomposition of sewage.

The pollution of rivers by town sewage has become a gigantic evil. Attempts—always unsuccessful—have been made to deprive sewage of its solid ingredients before it passed into the rivers. Disinfectants have been employed, and with greater success. I am, however, of opinion that in dealing with sewage pollution, preventive measures alone will prove efficacious. The drainage of towns should not be permitted to pervert the pure waters of our rivers into foul and lethal streams. (1)

In London this principle is now recognized and put into practice. The sewage of a large portion of the city is conveyed in close sewers to many miles below, where it is applied to the purpose of fertilizing the soil. The earth, and not the water, is the natural destination of the *ejectæ* of the population; and to use the words of Liebig: "If clearly understood and properly managed, the employment of sewage will prove a blessing to agriculture; and those who, by unwearied perseverance, have at last seen the consummation of their labors, may justly be looked upon as the benefactors of their fellow men."

London is the best sewered large city in the world, and the excellence of its provisions for thorough drainage, which is one of the causes of its comparatively low death-rate, renders it a model city in this respect.

The California State Board of Health consider themselves, therefore,

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(1) I cannot here refrain from calling attention to a recent instance of possible "pollution of rivers" in California. In the construction of the new Branch State Prison at Folsom, provision has been made for the discharge of the entire sewage into the American River. As the fall in this river is very rapid, more like that of a mountain torrent, and during the greater part of the time the river dwindles into a very insignificant stream, there is great danger of the water supply in Sacramento becoming poisoned, especially during the dry season. It is to be hoped that the proper authorities will see to it, that the supply-pipe of the waterworks be carried up beyond Bannon's Slough, where the American now debouches into the Sacramento River.

fortunate in having secured the services of one of their members, (1) while on a visit to Europe, whose personal exertions enabled him, through the proper authorities, to have access to the Engineer's Department of the Metropolitan Board of Works. In another part of this report will be found an abstract of the main features of the systems of sewerage adopted in London and Paris, illustrated by drawings, copied from the original drafts and plans, and from which it is hoped many valuable suggestions may be derived, in the modification of similar systems for the benefit of our own cities and towns. The article, though condensed, covers the whole ground, and embodies the germs of mechanical principles deduced from centuries of experience, and from which every error has been eliminated. At the commencement of the reconstruction of the sewers of London, much trouble was met with and an experience passed through which our American cities must sooner or later undergo. After a long series of observation and experimentation with fluids of different densities and of various ingredients, in which floats of diverse materials were employed, the water-carriage system was finally adopted. This, it would seem, is the best adapted to the varied requirements of a city population for effecting the speedy removal of the principal matter liable to decomposition. It will also be found equal to any other system in securing the material elements that have to be utilized; but it should not be overlooked that other systems are applicable, and may be adopted with manifold advantage when circumstances are such as to debar the entire use of water-carriage. Earth and other materials of this character have from time to time been recommended and used, more with a view to deodorize and fix the elements of decomposition, so as to render the matter to be dealt with less baneful in its effects on health when accumulating in towns, and also as a means of securing its manurial value. In another part of this report will be found a valuable paper containing all that is essential to be known for present purposes respecting the dry earth method of treating refuse.

Recently a new system—the pneumatic, proposed by Captain Charles T. Liernur, Military and Civil Engineer, who has had practice in engineering on both sides of the Atlantic—is being brought into use in Holland and Austria, and it appears is likely to work very satisfactorily. The pneumatic system "proposes to draw off fecal matters and the polluted air by pipes connected with steam-worked air pumps. These pumps are attached to air-tight reservoirs beneath ground, in which, by exhaustion, about three-fourths vacuum is constantly maintained. From these large tanks pipes are laid along the principal streets, and at intervals smaller street tanks are placed, communicating by small, short conduits (or pipes, with a sort of valve in each), with the closets in each house. By partial exhaustion of the air in each of these receptacles for the sewer gas and effete matter, without the aid of water to flush the closets, the gas is drawn off from the house pipes, and lodged in the main reservoirs, where it is finally disposed of without detriment to the public health." By the use of stop cocks, this process is also effective in removing the excreta deposited in the house-drains. No water is required for flushing the pipes, and it is said, by the use of one fourth of the water now commonly employed, the pneumatic system will do

(1) Dr. L. C. Lane, whose place in the State Board of Health is now filled by Dr. James Murphy.

the entire work, and in a much more perfect manner than is possible with the water-carriage system alone.

The City of Hague, "after having submitted Captain Liernur's plan to a committee of professional inquiry, resolved at once to give it a fair, practical trial at the public expense." Here, every night a steam engine comes to the reservoirs, a vacuum is created in each by an air pump, and the contents of the house pipes are shot into the reservoirs. When a reservoir has relieved all the houses connected with it, its own contents, solid, liquid, and gaseous, are pumped by steam into a tender attached to the engine. As fast as these tenders are filled, they are forwarded to the railroad, and their contents are discharged into air-tight casks, for transportation to the farmers. Thus, every night the entire city is relieved of its excreta, without disturbance of or annoyance to the inhabitants.

The pneumatic system was tested at the Vienna Exhibition last year, being attached to a part of the exhibition building, and was found to act satisfactorily. It was there inspected by the Emperor William, who manifested his appreciation of the great value of the process by bestowing upon its inventor the Order of Knighthood. It has been indorsed, it appears, by the International Medical Congress of Vienna, who are convinced, from experiments made in their presence, that "the entire system is capable of doing its work completely." In Amsterdam and Leyden it has been practically applied to the districts of the poorer classes, whose ranks had been yearly decimated by the poisonous sewer gases incident to the water-carriage system. It has also been introduced most successfully into the Government buildings at Prague, while it has been applied to districts in that city, by a private company, upon the sole condition that the company shall have the sewage matter.

One great advantage which this system appears to possess is that of absolute independence of the care of householders and servants; doing its work in spite of negligence or interference. If the system proves to be as perfect as its advocates claim that it is, it certainly ought soon everywhere to take the place of the water-carriage system.

For these reasons, we have devoted a large space in our report to the first complete and authentic account of this system, published in the "Sanitary Record," of London. It is worthy of the most attentive consideration of our municipal authorities.

THE INSANE AND INEBRIATE—PROBATIONARY ASYLUMS, ETC.

The proposition to establish probationary asylums for the care of the insane in cases of incipient or suspected insanity, and also a Refuge for the Inebriate, is well worthy the attention of our legislators.

Nephalism, the term now used in Europe to designate the temperance movement, is rapidly gaining votaries in all parts of the civilized world, to oppose the degeneration of the human race, with all its hereditary results; and the curative recourse suggested, by the establishment of probationary asylums, commends itself as one of the most efficient and humane expedients which the friends of temperance can encourage. If ebriety is temporary insanity, let it be treated as such without having recourse to the dungeon cells of a city prison.

In this connection I would call attention to the communications, to be found in this report, from Dr. G. A. Shurtleff, Superintendent of the Stockton Asylum, and Dr. Edwin Bentley, Superintendent of the Napa Asylum, in response to certain inquiries as to the prevalence of insanity

at the present time in California, and the condition of the respective asylums in their charge. While it is very satisfactory to learn that speedy relief is about being afforded to the dangerously crowded state of the former institution, I would, at the same time, urge the necessity for making ample provision for the earliest possible completion of the entire new structure. As suggested in my former reports, more land should be purchased in the immediate surroundings for lawns and garden walks; and especially should that portion of the tract encompassing the source of the mountain brook, on which the water supply is hereafter to depend, be permanently secured.

CLIMATOLOGY AND CONSUMPTION.

The first step in establishing a medical climatology involves a masterly acquaintanee with all the meteorological agencies which influence the animal organization, as well as those which make up climate. In our extensive State we have all the known conditions of climate, both meteorological and medical, and in this vast range, it is confidently believed, will be found the conditions most favorable to the recovery from all forms of disease. These, however, can be found only by patient, plodding work with the thermometer, psychrometer, wind-vane, rain-gauge, etc. For this purpose an army of observers is needed, while we have only here and there a solitary sentinel. As a partial contribution to these desirable results some of the leading features of the climate of Sacramento and San Francisco—representative points of the interior and coast regions—derived from a long series of observation, will be found elsewhere under the above caption. Some general results, also, will be found in the isothermal lines on the map illustrative of the article on malarial fevers and irrigation. The subject is of great importance, partly for the reason that we do not yet understand the various ways in which climatic conditions and changes cause sickness and death, although we do know that such is the fact; many fatal diseases prevailing at certain warm and dry seasons, and certain others during severe cold and wet seasons. Perhaps, to borrow the metaphor of an affiliated Board, (1) it may not be thought wild enthusiasm to hope that the time may yet come "When the chief signal officer of the public health department shall be able to make some such announcement as that 'because of the extreme dryness and coldness of the atmosphere, all who expose themselves unduly thereto, and who do not provide against the danger by artificial moisture, as well as heat in their rooms, are at this time in danger from inflammation of the lungs and from croup;' or 'because of the great warmth and moisture of the atmosphere there is now great danger to children from diarrheal diseases, especially in cities and places where there is not an abundance of pure fresh air.' Warning signals might well be published concerning dangers to life and health through numerous other means than shipwreck, and through many others connected with meteorology. And this is only possible through the use of long series of accurately recorded observations."

CONTINGENT EXPENSES OF THE BOARD.

It will be seen that the expenses of the Board have fallen within the

(1) Second Annual Report of the State Board of Health of Michigan.

limit prescribed by the State. It is the intention of the Board so to manage the means at their disposal that similar results may always attend, while, at the same time, they will earnestly endeavor to make their investigations and reports as valuable as circumstances will permit.

Twenty-four months rent of office, to date	$1,200 00
Expressages and postages (for two years)	145 00
Traveling expenses of Secretary (for two years)	448 40
Paid for drawings of plans and maps	150 00
Traveling expenses of Henry Gibbons	280 00
Traveling expenses of A. B. Stout	280 00
Traveling expenses of Luke Robinson	120 00
Traveling expenses of F. Walton Todd	108 00
Traveling and other expenses of L. C. Lane	96 80
Total	$2,828 20

Respectfully submitted, in behalf of the California State Board of Health.

THOS. M. LOGAN, M. D.,
Permanent Secretary.

Sacramento, July 1st, 1875.

REPORT

OF THE

PERMANENT SECRETARY OF THE BOARD.

REPORT

OF THE

PERMANENT SECRETARY OF THE BOARD.

To the State Board of Health:

GENTLEMEN: In accordance with our organic law and my duties as your executive officer, I beg leave to offer, for your acceptance and presentation to the State Legislature, the accompanying report. You will perceive, in that portion addressed to the Governor, that I have already referred to some of the leading topics which have occupied our time and deliberations, calling special attention to such questions as, in our opinion, required legislative action. Working as we do for the public, and writing, not for the professional, but lay reader, I now propose to give the results, rather than the details, of our labors, under appropriate headings or groups, in as simple and perspicuous a manner as possible; and afterward to arrange, in the order in which they were read, discussed, and amended at the several meetings, the papers, embodying the investigations and studies of the committees and individual members of the Board.

All of which, it is hoped, will meet your approbation.

THOMAS M. LOGAN,
Permanent Secretary California State Board of Health.

SACRAMENTO, July 1st, 1875.

VITAL STATISTICS.

In the last biennial report, certain suggestions were made, pointing out how the laws relating to the registration of marriages, births, and deaths might be so amended as to make provision, by compulsory fines, for more complete statistics, than it is found possible, to collect under existing circumstances. In accordance with these suggestions, some of the friends of progress in this matter drew up a bill for the amendment of the law, which received the approval of the Hospital Committee of the Senate, to which it was referred, but for lack of time it failed to become a law. The reasons why the law should be amended are stronger and more cogent now than ever, because the returns have been becoming more and more irregular and imperfect, and are, therefore, utterly worthless for the purposes of statistical compilation and discussion. As stated in my report to the Governor, society at large has an interest in these statistics over and above the personal interest of the few who record them, and the State should pay for their collection. Certainly no expense for recording them should be borne by persons placing them upon record. As the law now stands, "the Secretary of the State Board of Health shall prepare and furnish to the Clerks of the several Boards of Supervisors of each county, a model for blank forms, of suitable quality and size, to be used as books of records;" but no provision is made as to how these books shall be paid for, nor is the Secretary authorized to have them printed. This is, perhaps, the principal reason why the law has become inoperative. Some of the County Clerks have provided themselves with suitable books, and make prompt returns, but the law does not make distinct provision therefor. From the experience we have had, it would seem that the clerical work of so elaborate a kind as that involved in the registration of marriages, births, and deaths, requiring compilation from the original returns and the necessary computations, should be committed to the Secretary of State, who is charged, ex officio, with the duty of supplying stationery, books, printed matter, etc., for State purposes; while that part of the surveillance and tabulation which exacts a certain amount of technical knowledge to make them valuable, might remain under the control of the Secretary of the State Board of Health. This is the plan adopted in other States, where registration laws are now being carried out with better success, after many years of abortive efforts and trials.

It is to be hoped that no longer time will be consumed in attempting to carry out the present defective plan The sooner a different system is inaugurated the better, for it must be borne in mind that the main value of such statistics is not in their immediate application to business affairs for a few days, weeks, or months only, but in those general principles which are only reached through long series of observations, extending through many years; and then it depends upon their accuracy, which is better secured by prolonged than by hasty labor. Life tables are of great pecuniary importance to the people, inasmuch as the life insurance business is based upon them; but no life insurance company would trust or venture their capital on the mortality-expe-

rience of a single year in a single locality; and what is true in this particular of this one item of vital statistics, is true of other items.

By means of the commendable coöperation of the members of the medical profession in various parts of the State, I am now enabled to supplement, for such as it was expected would be furnished through the instrumentality of the registration laws, the following

MORTUARY AND SANITARY STATISTICS.

Pursuing the plan adopted in our former reports, I have prepared similar tables for the calendar year eighteen hundred and seventy-four, showing, as completely as it is possible to do under existing circumstances, the death-rate in twenty three towns and localities in different sections of the State. The population of these places has been put down, for the most part, in accordance with the estimate of the medical gentlemen (1) furnishing the monthly returns of mortality, and who are best able to judge as to the increase or decrease of the inhabitants within the area of their practice. By means of these monthly returns, which have been received continuously for a number of years, we are furnished with the various data that are required for making the present results comparable with those of our former reports.

Unfortunately, owing to the difficulties which attend a correct diagnosis, such as the less definite employment of nosological nomenclature, which allows many deaths to be credited to the wrong disease, and the shameful fact that the most ignorant non-professional persons are permitted to give a certificate of death, but little reliance can be placed on such statistics as to special diseases. They may be trusted, nevertheless, in regard to total mortality, and to such particular diseases as consumption, diseases of the lungs, and of the stomach and bowels, scarlatina, diptheria, and typho-malarial fevers, which are popularly well known, and to which I have chiefly confined my investigation. My present purpose is only to show, in as condensed a form as possible, by means of tables, a few of the practical facts investigated in such researches, such as the death rate, as well as the total mortality from all causes, and from certain principal diseases, severally and in groups, with the proportion of deaths from all causes and to population—*i. e.*, the prevalency and fatality of certain diseases.

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(1) The names of these gentlemen will be seen in Table No. 1, in connection with the results of their labors. I would here, also, take occasion to acknowledge the receipt of further returns of monthly mortality, as well as of sickness, from the following named contributors, with their places of residence, viz: Dr. A. Trafton, *Woodbridge;* Dr. Q. C. Smith, *Cloverdale;* Dr. A. H. Cochrane, *Watsonville;* Dr. J. J. Sawyer, *Susanville;* Dr. M. C. Parkison, *Antioch;* Dr. E. Parramore, *Yolo County;* Dr. Thos. Ross, *Woodland;* Dr. G. A. René, *San Bernardino;* Dr. H. F. Hall, *Modoc County;* Dr. J. P. Jackson, *Stanislaus County;* Dr. M. S. McMahan, *San Jose;* Dr. C. G. Kittredge, *Oakland;* Dr. J. H. Crane, *Petaluma;* Dr. C. B. Robertson, *San Andreas;* Dr. M. Baker, *Tulare County;* Dr. W. W. Davies, *Salinas;* Dr. W. L. Graves, *Centreville;* Dr. W. Nichols, *Pajaro;* Dr. J. Bradford Cox, *Healdsburg;* Dr. L. F. Jones, *Sierra City;* Dr. W. B. H. Dodson, *Kelsey;* Dr. J. S. Hammond, *Lockford;* Dr. P. B. M. Miller, *Oroville;* and Dr. J. E. Pelham, *Shasta.*

Although the reports from these various sources are not available for present purposes—because of want of continuity with some, and because of being of too recent a date with others—still they have proved useful in furnishing the Board with prompt and reliable information from so many important points, and will on a future occasion enter into our computations, provided no interruption is allowed to occur in the regular monthly returns. Such reports must cover the twelve consecutive months of the calendar year to fulfill all the purposes for which they are required.

TABLE No. 1.

Showing the total mortality, as well as that by the most prevalent diseases, in twenty-three localities, comprising about half the population of the State, with the ratio of deaths to one thousand of population, from January, eighteen hundred and seventy-four, to January, eighteen hundred and seventy five; also, the authorities for the data.

Localities.	Population	Total number of deaths	Ratio of deaths per one thousand of population	Prevalent Diseases.						All other diseases and causes of death	Authorities.
				Consumption	Other diseases of lungs	Diseases of stomach and bowels	Diphteria	Scarlatina	Typho-malarial fevers		
San Francisco	200,770	4,044	20.1	556	367	293	42	255	122	2,409	San Francisco Board of Health.
Sacramento	21,000	313	14.9	53	37	19	.....	10	15	179	Sacramento Board of Health.
Petaluma	4,514	67	12.6	16	2	4	5	3	3	34	G. W. Graves, M. D.
Dixon and surroundings	6,000	17	2.8	2	2	1	.....	.....	1	11	A. H. Pratt, M. D.
Stockton	12,000	136	11.3	17	7	11	1	31	9	60	Stockton Board of Health.
Marysville	5,000	118	23.6	16	11	8	.....	.....	16	67	A. B. Caldwell, M. D.
Placerville	1,562	26	16.6	2	1	.....	.....	.....	3	20	E. A. Kunkler, M. D.
San Diego County	6,000	35	5.8	15	1	1	.....	.....	.....	18	Thomas C. Stockton, M. D.
Oroville and surroundings	2,000	28	14.0	2	2	5	3	.....	2	14	J. M. Vance, M. D.
Oakland	20,000	278	*13.9	27	28	44	4	21	11	143	Oakland Board of Health.
Los Angeles and surroundings	15,000	335	21.6	36	11	19	1	34	7	227	H. S. Orme, M. D.

Truckee and surroundings	2,000	21	10.5	1	2	2	.....	.....	.....	16	.....William Curless, M. D.
St. Helena and surroundings	3,000	14	4.6	4	3	1	.....	1	.....	5	.....C. F. A. Nichel, M. D
Napa City	5,000	52	10.4	8	12	3	.....	1	4	24	.....M. B. Pond, M. D.
Watsonville	2,500	49	11.6	9	4	2	.....	.....	1	33	.....C. E. Cleveland, M. D.
Folsom and surroundings	3,000	24	8.0	4	3	3	.....	.....	3	11	.....S. Lyons, M. D.
Santa Barbara	5,000	120	24.0	34	3	3	.....	2	1	77	.....C. B. Bates, M. D.
Redwood City	3,000	47	15.6	10	3	5	1	1	1	26	.....C. A. Kirkpatrick, M. D.
Santa Cruz	3,500	30	8.5	11	2	7	.....	.....	.....	10	.....C. L. Anderson, M. D.
Suisun and Fairfield	6,000	19	3.1	4	2	2	.....	.....	.....	11	.....J. F. Pressley, M. D.
Colusa and surroundings	4,000	58	14.5	10	6	5	.....	.....	9	28	.....Luke Robinson, M. D.
Downieville	1,500	15	10.0	3	2	2	.....	1	.....	7	.....Alemby Jump, M. D.
Siskiyou County	7,902	42	5.3	2	9	8	.....	.....	3	20	.....Daniel Ream, M. D.
Totals	340,748	5,888	17.2	842	520	448	57	360	211	3,450	

* Twenty-four stillborn are included in the computation for Oakland, excluding which would reduce the ratio to 12.6. See report of Health Officer.

In Table No. 1 is shown the death-rate in twenty-three principal cities and towns of the State, as well as the total mortality by all causes in these localities, and the deaths and percentage of deaths by some of the most generally prevalent diseases.

The twelve months included in this table, show the ratio of deaths per one thousand of population to be 17.2. In our last biennial report for the fiscal year eighteen hundred and seventy one–seventy-two, which was the healthiest year ever experienced in California, this ratio was 17.1; while in our first biennial report for eighteen-hundred and seventy–seventy-one, the ratio was 18.8. Thus it is seen, at a glance, that notwithstanding the unprecedented immigration during the last two years, revealed in the rapidly increasing population of most of our towns, the death-rate has been but slightly affected. This is the most remarkable, when we reflect upon the great numbers who now resort to California as a sanitarium, in the last stages of consumption, and dying here add to the sum of mortality.

In order to arrive at a distinct comprehension of the bearing of figures in this table, it must be borne in mind that the limit of percentage of deaths, which statisticians agree to be unavoidable, is eleven to one thousand. All above this they hold to be preventable, by precaution, in healthy countries. In rare instances the rate falls below the necessary limit, as, for example, in Michigan, where it was as low as eight to the thousand. I am not aware, however, that what is termed the necessary rate has ever been reached in cities. Mortality is always much greater where the population is dense, and in London the standard sought to be obtained is seventeen in one thousand, though, in fact, this has thus far always been exceeded. In practice, it is generally conceded that city mortality, when under twenty, shows a very high rate of health. When varying between twenty and twenty-five, it shows a fair standard of health; and when reaching thirty, it shows an alarming degree of sickness.

The following Table No. 2 has been compiled for the purpose of affording the means of forming a judgment respecting the salubrity of our three principal cities, when compared with other American cities, particularly in relation to consumption. It is based chiefly on the authority of the Registrar of Vital Statistics, Brooklyn.

TABLE No. 2.

Comparative mortality statistics for eighteen hundred and seventy-four.

Cities.	Population	Total number of deaths.	Per one thousand	Deaths from consumption	Per cent of consumption to total mortality.	Consumption per 1,000 of population
New York	1,040,000	28,727	27.62	4,033	14.04	3.88
Philadelphia	775,000	15,238	19.66	2,304	15.12	3.10
Brooklyn	450,000	11,011	24.46	1,267	11.45	2.81
St. Louis	450,000	6,506	14.45	581	8.93	1.29
Chicago	395,000	8,025	20.29	630	7.85	1.62
Boston	375,000	7,812	30.83	1,309	16.75	3.46
Baltimore	350,000	7,401	21.14	1,036	14.00	2.96
Cincinnati	260,000	5,321	20.46	.....	.....	.....
New Orleans	207,000	6,798	32.76	.....	.....	.....
San Francisco	200,770	4,044	20.14	556	13.75	2.77
Washington	150,000	2,959	19.72	471	15.90	3.14
Cleveland	145,000	2,195	15.13	178	8.10	1.23
Pittsburg	137,000	3,381	24.68	331	9.78	2.41
Milwaukee	100,000	1,909	19.09	136	7.12	1.36
Providence	99,608	1,983	19.90	269	13.58	2.70
Rochester	80,000	1,405	17.56	188	13.38	3.16
Richmond	65,000	1,591	24.47	231	14.52	3.55
New Haven	59,000	1,073	17.85	197	18.35	2.96
Charleston	50,000	1,948	38.96	98	5.05	1.96
Memphis	50,000	1,148	22.96	137	11.93	2.74
Fall River	43,000	1,177	27.21	148	12.55	3.41
Dayton	34,000	479	14.09	68	14.19	2.00
Galveston	34,000	626	18.41	16	.25	.....
Peoria	30,000	338	11.16	32	9.46	1.06
Sacramento	21,000	313	14.90	53	16.93	2.52
Oakland	20,000	278	12.65	25	8.99	1.25

The plan of giving the mortality rates for a series of years, affords a much more correct means of comparison than can be obtained by examination of the rates of a single year.

The following table, Number 3, is extracted for this purpose from the report of the Health Officer of San Francisco. The rates for eighteen hundred and seventy-four being added, so far as they have come to hand.

By this means it is readily seen that a serious epidemic affecting some cities one year and others the next, would, were one year the basis of judgment, cause unjust discrimination.

This is particularly noticeable in New Orleans and St. Louis. In the first named city the rate was 54.3 in eighteen hundred and sixty-seven, but far less in all the other years; and, in the second, the rate of 46.3 in eighteen hundred and sixty six, was not half as much in any succeeding year, save eighteen hundred and sixty-seven. A glance through the table shows that a uniformly high rate prevails in New York and

New Orleans, and in several of the English towns; while the reverse obtains in regard to Philadelphia, San Francisco, St. Louis, Cincinnati, and also London and Birmingham. The great similarity between the average rates in a number of our own cities and those of Great Britain affords an interesting feature. While St. Louis carries off the palm for being the healthiest *large* city in the world in the year eighteen hundred and seventy-four, we, nevertheless, see that in eighteen hundred and sixty-six, the rate was 46.3 in one thousand. The percentage in San Francisco and Philadelphia corresponds very closely, and gives them rank as very healthy cities.

Of smaller towns Oakland ranks next to Peoria, where, as seen in Table Number 2, the rate was 11.1 in eighteen hundred and seventy-four. Sacramento ranks next to Oakland.

TABLE NO. 3.

Showing the number of deaths annually per thousand of inhabitants in the following cities of Europe and America, for a series of years.

UNITED STATES.	1866.	1867.	1868.	1869.	1870.	1871.	1872.	1873.	1874.
New York	33.5	32.3	25.4	29.4	29.3	27.5	32.6	27.9	27.6
Philadelphia	24.3	19.8	20.6	20.2	22.7	22.6	26.3	20.3	19.6
Brooklyn	27.8	27.8	24.4	.....	24.1	24.7	30.0	25.2	24.4
St. Louis	46.3	30.2	20.6	20.6	21.3	16 8	23.0	.....	14.4
Chicago	32.2	21.2	23.7	23.2	24.5	21.5	27.6	23.9	20.2
Baltimore	.....	24.4	.....	.....	25.9	25.2	25.9	.....	21.1
Boston	22.8	.....	.....	23.3	24.3	22.7	30.5	28.4	30.8
Cincinnati	34.9	20.1	24.6	18.0	.....	21.7	20.5	22.8	20.4
New Orleans	.....	54.3	27.4	.....	36.2	28.0	30.6	35.8	32.7
San Francisco	21.0	19.2	25.5	23.3	21.0	17.4	17.5	20.3	20.1
Sacramento	19.7	16.0	24.6	26.0	23.2	19.1	19.5	20.1	14.9
Oakland	.....	.....	.....	.....	.....	.....	.....	14.4	12.6
Average, fourteen large cities	.....	.....	.....	.....	2.46	24.1	26.6	.....	.....
GREAT BRITAIN.									
London	.....	.....	.....	.....	24.0	24.7	21.4	22.4	.....
Liverpool	.....	.....	.....	.....	31.1	35.1	27.6	25.9	.....
Glasgow	.....	.....	.....	.....	29.8	32.9	28.4	.....	.....
Manchester	.....	.....	.....	.....	27.8	31.2	28.5	30.2	.....
Birmingham	.....	.....	.....	.....	21 1	24.9	22.9	24.8	.....
Dublin	.....	.....	.....	.....	24.0	26.2	28.9	.....	.....
Leeds	.....	.....	.....	.....	28.2	26.4	27.8	27.5	.....
Sheffield	.....	.....	.....	.....	25.2	28.3	26.0	.....	.....
Edinburgh	.....	.....	.....	.....	26.3	26.9	26.4	.....	.....
Bristol	.....	.....	.....	.....	29.9	23.2	22.0	.....	.....
Newcastle	.....	.....	.....	.....	25.4	32.2	26.3	30.3	.....
Average, twenty-one large towns	.....	.....	.....	.....	25.8	26.9	24.3	24.0	.....

Reverting to Table No. 1, we find Stockton taking precedence of Oakland, and even of Petaluma, which, in our last report, presented the lowest death-rate of our smaller towns. Of rural towns, Dixon takes a slight precedence of Suisun and Fairfield, which are shown to be the healthiest localities in the State. St. Helena, Siskiyou County, and San Diego County next follow, in the order in which they are respectively

named. The highest death rates are found in Santa Barbara and Marysville. The mortality by consumption in the former place, as well as the total mortality, is aggravated by extraneous causes—the advent of the phthisical and other valetudinarians in search of a more favorable climate, which invalidate any legitimate deductions as to local salubrity. Not so with the latter place, which affords an exemplification of what has been advanced in another part of this report respecting the slow toxic effect of malaria in the production of phthisis. Our statistics show a high death-rate here, both from malarial fevers and consumption, the ratio per one thousand of population being in both cases 3.2. As is well known, pulmonary affections are often associated with repeated attacks of intermittent fever, followed by malarial cachexia; and in this way we can account for the large ratio of deaths by consumption in Marysville, which is confessedly proclivous to malarial diseases.

Passing on from the consideration of the variation in the death-rate of these different localities, which demonstrates that different causes are at work, we proceed in the search for these and their preventives, to examine into the total number of deaths each month, in connection with sex, race, age, and nativity.

The large disproportion of the sexes is the first feature that strikes attention in Table No. 4, there being sixty-four per cent male to thirty-six per cent female decedents among the total deaths. This percentage has not varied materially within the last six years, although formerly the disproportion was much greater, in consequence of the great rush hither of male adventurers without their families. The last United States census shows that about the same disproportion of deaths in the sexes obtains in all the new States and Territories, owing mainly to the fact that the males comprise about sixty-two per cent of the population. Still, making allowance for this fact, the ratio of deaths for males continues too much in excess, and sustains what was advanced in our last report, respecting the very natural supposition that, with his more vigorous frame and sturdier make, the vitality of the male should be greater than of the female, his average life longer, his greatest age greater. That it is not so, however, is a problem which science has not yet solved.

"This law of population holds good in every country of which we have any statistics; about five per cent more males than females are born, but at five years of age more girls are alive than boys. Again, at every period of life, the "expectation of life," as insurance companies term it—that is, the average term yet to live—is greater in women than in men. And, finally, of very old persons, the large majority are women. So true is this, that the last census of France shows that at the age of ninety years, there were three women to two men, and at the age of one hundred, the number of women was more than sixteen times the number of men." (1)

With regard to race, the mortality of the black is nearly one and a half per cent, while the black population, according to the United States census, is less than one per cent of the whole. This shows the same larger mortality than that of the whites, which has been observed everywhere, and especially in the Southern States, but which cannot reasonably be ascribed to the influence of race as its chief factor, according to the popular idea, unless it be maintained that this high comparative death-

(1) George H. Naphey's Counsels on Nature and Hygiene.

rate is the cause of the Negro's poverty and adverse social and domestic conditions. The white race is no more above the influence of bad sanitary conditions than the Negro, and exhibits an equally high death-rate when the necessary consequences of injurious surroundings exist. Take, for example, the account of the death registers in New York: In eighteen hundred and sixty-eight the deaths in the tenement houses, and in the hospitals and other charitable institutions (the inmates of which are mainly derived from the tenement houses), constituted 75.79 per cent of the total mortality of the city. In other words, this smaller half of the population of New York furnished more than three times as many deaths as the larger half who lived in private dwellings. But while the facts in our possession, and which cannot be shown in our tables, can hardly be used to sustain the opinion that the mortality of the Negro race is greater here than that of the white, *ceteris paribus*, on account of the mere influence of race, *per se*, they clearly confirm what has been observed everywhere respecting the relative susceptibility of the white and colored races to some of the causes of disease and death.

Not to be too circumstantial, the greater liability of the Negro, especially to pneumonia, and other diseases of the respiratory organs, and the tubercular diseases in general, appears to be chiefly instrumental in the production of a large comparative mortality; while, on the other hand, the well attested exemption from malarial diseases, diptheria, and scarlatina, in squaring the account, would leave a very small, if any balance at all, against the Negro race. The Fauna, Flora, and races of men have been created with different inherent adaptations for each particular clime. Transplanted to an uncongenial soil they do not flourish, but on their native grounds are strong and hardy. This well established fact presents the reason why the Negro is so proclivous to various inflammatory diseases of the respiratory organs, while he seems to luxuriate on the malaria of his native zone.

The remarks respecting the mortality of the Negro race apply, in a certain degree, also, to the copper-colored races, which include Chinese and Indians. These constitute about ten per cent of the population, while the mortality is 11.3 per cent. This, however, does not represent the real rate, inasmuch as the Chinese decedents are excluded from the computations for some localities. The mortality of the Chinese by malarial fever was frightful, in the neighborhood of Oroville, during the months of August, September, October, and November, and yet this does not appear in the table. In San Francisco, according to the annual report of the Health Officer, ending June thirtieth, eighteen hundred and seventy-four, the deaths among the American population are stated to have been at the rate of 19.8 per one thousand, while the Chinese rate was 32.1 per one thousand. But are we thence necessarily to infer that the Mongolian race is of essentially inferior vital stamina to the Caucasian; less able, because of race, to resist the causes of disease? Bad as their sanitary surroundings are in the overcrowded and filthy condition of the quarters which they occupy, we do not find that there is as great an excess of mortality in the degraded Chinaman as we have already seen to exist among the tenement-house population of New York.

As an offset to the terrible mortality by malarial fever, just alluded to, among the Chinese near Oroville, Dr. J. Bradford Cox, physician to the Hoopa Valley Indian Reservation, in Humboldt County, reported that out of three hundred and one sick Indians treated by him during

some of the special causes of this mortality. It ... hat:

TABLE NO. 4.

Showing the total mortality from January, eighteen hundred and seventy-four, to January, eighteen hundred and seventy-five, by sexes, race, months, ages, and nativities.

CITIES, TOWNS, ETC.	Total deaths	Sex.		Race.			Months.												Ages.										Nativities.			
		Male	Female	White	Copper	Black	January	February	March	April	May	June	July	August	September	October	November	December	*Under one year of age	One and under five years	Five and under ten years	Ten and under twenty years	Twenty and under thirty years	Thirty and under forty years	Forty and under fifty years	Fifty and under sixty years	Sixty and under one hundred years	Unascertained	Pacific States	Atlantic States	Foreign countries	Unascertained
San Francisco	4,044	2,601	1,443	3,627	445	62	392	301	305	301	295	345	355	357	321	379	320	332	823	501	193	160	497	628	609	321	284	28	1,547	582	1,885	30
Sacramento	313	209	104	252	52	9	22	26	35	24	20	25	24	28	21	26	25	28	47	37	16	23	42	53	41	24	57	3	107	92	113	1
Petaluma	67	35	32	62	5	.....	6	6	4	6	6	3	5	5	7	7	6	6	5	9	11	6	6	10	8	6	7	.....	30	20	17	.....
Dixon and surroundings	17	9	8	17	.....	.....	4	.....	.....	.....	1	1	.....	3	4	.....	1	3	5	.....	2	3	.....	3	.....	1	3	.....	11	5	1	.....
Stockton	136	71	65	124	9	3	7	6	9	14	18	9	11	16	10	9	11	16	21	27	13	14	9	13	18	12	9	.....	69	27	40	.....
Marysville	118	85	33	77	35	6	4	7	6	11	13	4	9	8	14	15	10	8	12	6	3	5	12	32	25	15	9	.....	23	28	67	.....
Placerville	26	23	3	25	.....	1	3	2	1	4	3	.....	1	7	1	1	1	2	.....	1	.....	1	.....	3	7	9	5	.....	1	15	10	.....
San Diego County	35	25	10	33	1	1	3	3	3	2	4	3	.....	4	1	2	.....	7	4	1	.....	2	3	11	5	4	4	.....	7	18	8	2
Oroville and surroundings	28	23	5	26	1	1	4	4	.....	.....	.....	.....	1	.....	1	7	10	1	5	2	.....	7	.....	3	5	3	.....	1	12	8	7	1
* Oakland	278	145	133	264	7	7	16	17	16	19	20	36	29	22	24	33	18	31	88	44	24	10	22	21	30	17	22	.....	153	67	58	.....
Los Angeles and surroundings	335	215	120	247	88	.....	23	21	22	21	32	34	38	29	26	24	29	36	65	71	21	19	28	32	36	13	17	33	161	24	78	72
Truckee and surroundings	21	14	7	18	3	.....	2	1	1	.....	2	.....	.....	5	3	2	2	3	6	1	.....	.....	2	5	5	2	.....	.....	7	9	5	.....
St. Helena and surroundings	14	9	5	14	.....	.....	2	1	.....	1	2	3	.....	1	3	.....	1	1	3	1	1	1	4	2	2	.....	.....	.....	4	7	3	.....
Napa City	52	37	15	42	8	2	4	5	5	2	4	3	1	5	8	4	2	8	9	6	1	4	6	9	7	3	8	.....	19	13	19	1
Watsonville	49	28	21	46	3	.....	4	5	5	2	3	2	5	11	3	3	4	2	19	3	.....	.....	6	3	4	4	6	.....	29	12	8	.....
Fobora and surroundings	24	18	6	24	.....	.....	1	.....	2	4	1	.....	2	2	4	3	4	1	.....	2	3	1	1	3	4	3	7	.....	6	6	14	.....
Santa Barbara	120	73	47	115	6	.....	16	14	12	11	10	7	7	8	4	6	8	11	20	17	5	8	18	13	18	8	3	.....	85	24	6	6
Redwood City	47	33	14	47	.....	.....	1	2	.....	1	7	4	4	1	6	11	7	3	10	2	3	3	5	6	4	6	8	.....	18	11	16	2
Santa Cruz	30	18	12	29	1	.....	3	.....	1	3	3	1	3	4	5	4	2	1	7	1	1	2	1	4	6	3	5	.....	13	8	9	.....
Salsun and Fairfield	19	13	6	17	1	1	.....	.....	2	2	4	3	1	.....	5	.....	1	.....	1	2	.....	3	.....	4	1	1	7	.....	10	4	5	.....
Colusa and surroundings	58	32	26	56	2	.....	2	9	7	2	.....	5	6	6	5	6	5	5	7	10	1	5	6	7	6	4	12	.....	23	20	8	7
Downieville	15	14	1	14	1	.....	.....	.....	1	2	2	1	3	2	1	2	1	.....	3	.....	.....	1	1	.....	6	3	2	.....	4	4	7	.....
Siskiyou County	42	26	16	40	2	.....	2	4	2	4	3	1	4	2	4	7	5	4	6	5	4	5	1	4	8	7	2	.....	20	13	9	.....
	5,888	3,756	2,132	5,125	670	93	521	443	500	486	459	487	500	507	484	551	482	509	1,175	747	301	290	663	869	857	474	447	65	2,359	1,016	2,392	121

* Twenty-four stillborn are included in the computation for this place.

the corresponding months of September, October, and November, at the former place, but two died. Not a single one of these, however, was a case of fever; Humboldt County being almost exempt from malarial fevers. This fact speaks strongly in favor of the viability of the native Indian race, whose powers of resistance to disease seem to be extraordinary, so long as he is not subjected to the habits of civilized life; but it is sad to know that all attempts to elevate the moral and intellectual condition of the aborigines produce physical deterioration. The same observation has been made by Livingston, Du Chaillu, and Sir Samuel Baker, respecting the Negroes of Central Africa. The last named authority says he never saw a case of mania nor met with more than one idiot. Africans never commit suicide and never go mad; the women never give birth to cripples or monsters. In his enumeration of diseases he never mentions tuberculosis or scrofula, but states that small-pox and dysentery are prevalent and fatal; that typhoid fever, measles, whooping cough, scarlet fever, croup, and diptheria are unknown.

Without entering into any further analysis of this division of our table, suffice it, that the white race is thus by comparison demonstrated to have the least proportionate mortality, and, consequently, to be the healthiest. But while admitting this prima facie evidence of the superiority of the Caucasian, in reference to resistance to disease, it must be remembered that nature is not responsible for our diseases, but that man himself is the originator, and that if he is ever made free from them it will be by correcting his own conduct, and bringing it into harmony with the conditions of healthy existence. If the advancement in health and length of days in California has resulted from the limited improvements that have already been made in our modes of life, since the American settlement, how great are we not warranted in believing the improvement will be when our conduct is brought into much closer harmony with sanatory laws. In some things pertaining to the preservation of health we have not improved, but rather retrograded. In the means for securing a copious supply of pure water; in the number, excellence, and efficiency of the magnificent sewers of ancient Rome for conveying quickly into the swift Tiber all the filth of that vast city; in the number of splendidly constructed public baths in which all were free to wash and be clean, the metropolis of our State will bear no comparison whatever.

California embraces within her boundaries every physical and climatic condition that is necessary to invigorate and energize the health and physique of her inhabitants. Like her analogue, in Ancient Greece, where even the thick air of Bœtia was insufficient to paralyze the mental energy of a Hesiod, a Corinna, or a Plutarch, and where everything seemed to thrive like seeds sown in a virgin soil—so here, while the mountains, like those of Thessaly, shall tutor the shepherd and the hunter in everything that gives prowess in bodily vigor, shall, also, the thin, bright, elastic air of our plains smile, like that of Attica did upon the brains and nerves of the Athenian, if we only but practically apply the knowledge they possessed of a perfect system of hygienic laws.

Another important class of facts derived from this table consists in the mortality by months, which we will now discuss in connection with some of the special causes of this mortality. It will be observed that:

The greatest number of deaths occurred in October	551
The next greatest number of deaths occurred in January	521
The next greatest number of deaths occurred in July	509
The next greatest number of deaths occurred in December	509
The next greatest number of deaths occurred in August	507
The next greatest number of deaths occurred in March	500
The next greatest number of deaths occurred in June	487
The next greatest number of deaths occurred in September	484
The next greatest number of deaths occurred in November	482
The next greatest number of deaths occurred in May	459
The next greatest number of deaths occurred in February	443
The least number of deaths occurred in April	436
Total for twelve months	5,888

As established in former reports, the greatest mortality was not coincident with the highest temperature, but occurred two or three months after this period, when the system, exhausted by the prolonged heat of Summer, yields to the pernicious influence of malaria. This is shown in the Comparative Table No. 5, to which attention is now called, while proceeding from all causes to the special, we trace, through the progression of the months, the fatal march of certain prevalent diseases.

The largest number of deaths caused by any one disease was (842) from consumption; (1) the greatest mortality by this disease being (93) in December, and the least (45) in July. For the purposes of comparison, and in order that the mortality of the three years covered by our reports may be seen at a glance, the monthly deaths of the previous years are placed in the left hand columns of Table No. 5. In making the comparison, however, the large increase of the State in population within the two last years (one hundred and fifty thousand, more or less,) must be kept in mind. As with consumption, we find the greatest number of deaths by other diseases of the lungs (62) occurred in December, and the least (21) in July. This corroborates what has been stated in other parts of this report respecting the influence of cold and damp weather in the causation of those diseases, and on the other hand, the beneficial effect of a warm, dry atmosphere.

(1) See remarks on this disease in articles on "Malarial Fevers and Consumption," and on "Climatology and Consumption."

TABLE No. 5.

Comparative table of mortality of certain prevalent diseases, by months.

Months.	Consumption			Other diseases of lungs			Diseases of stomach and bowels			Diptheria			Scarlatina			Typho-malarial fevers			Total		
	1870-71.	1871-72.	1874.	1870-71.	1871-72.	1874.	1870-71.	1871-72.	1874.	1870-71.	1871-72.	1874.	1870-71.	1871-72.	1874.	1870-71.	1871-72.	1874.	1870-71.	1871-72.	1874.
July	57	47	45	21	13	21	37	19	80	7	2	2	4	1	36	18	17	20	144	99	204
August	63	54	57	24	16	43	38	25	49	5	2	5	3	2	26	13	18	30	146	117	210
September	63	59	64	19	12	35	29	46	58	5	3	5	6	1	24	21	24	30	143	145	216
October	64	64	75	27	37	32	33	72	36	4	4	8	15	1	25	34	21	32	167	199	208
November	64	64	60	33	40	45	18	13	30	9	6	7	15	1	19	43	23	18	182	147	179
December	64	64	93	51	36	62	22	17	26	6	1	5	13	4	26	24	21	22	181	143	234
January	65	64	90	48	20	52	9	10	20	9	1	7	15	3	57	30	11	7	196	113	233
February	59	59	75	51	43	56	11	18	24	.....	1	2	6	4	23	13	14	13	140	139	193
March	70	74	81	42	35	56	12	10	16	2	3	5	4	3	39	13	18	13	143	143	210
April	69	73	66	23	38	45	8	9	15	4	.....	8	4	1	22	7	11	11	114	152	167
May	55	78	71	23	33	41	33	31	25	1	12	2	4	1	37	8	16	5	124	171	181
June	60	50	65	19	33	32	30	39	69	1	2	1	4	2	26	13	10	10	127	136	203
Totals	774	754	842	380	356	520	270	309	448	53	37	57	93	24	360	237	204	211	1,807	1,684	2,438

From diseases of the stomach and bowels, the greatest number (80) for any one month, recorded in our biennial reports, by diseases of these organs, occurred in July. Thirty-four of these were caused by cholera infantum, in San Francisco. This appears to be an exceptional instance, for the very inconsiderable mortality, heretofore, by this infantile disorder, has been cause for much congratulation. Probably in no large city in the country is there such immunity from this disease. In some cities, as New York and Chicago, the fatality is enormous. By the following statement, prepared by the Health Officer of San Francisco, for the fiscal year terminating with June, eighteen hundred and seventy-four, it appears that San Francisco has the lowest rate. It is remarkable that New York has eight times and Chicago seven times as many deaths, by these diseases, in proportion to population, as San Francisco. Only those under two years of age are included:

NUMBER OF DEATHS TO EACH 10,000 POPULATION.	San Francisco, 1873–4, exclusive of Chinese.....	New York, 1872.....	Philadelphia, 1873.....	Brooklyn, 1873.....	Chicago, 1873.....	Boston, 1873.....	Cincinnati, 1873.....	New Orleans, 1873.....	Buffalo, 1873.....	Providence, 1873.....	Liverpool, 1872.....	Birmingham, 1873.....
From infantile diarrhea (cholera infantum).....	5	42	15	25	34	24	9	7	14	11	17	16

Inasmuch as cholera infantum is a Summer disorder, and as San Francisco has no Summer climate, we must look to some accidental circumstances—as either foul air or adulterated milk, or both—as the causes of the unusual mortality by this disease. With pure air and wholesome food, cholera infantum can never prevail in our metropolis as it does in the Eastern cities.

Diptheria and scarlatina have occasionally prevailed since the epidemics of eighteen hundred and sixty and eighteen hundred and sixty-nine–seventy, but generally in a very benign form, as demonstrated by their low death-rate. This remark is especially applicable to the former disease. In June, eighteen hundred and seventy-three, however, the latter disease took a new departure in San Francisco, where, in the following December, it reached its culmination: the deaths amounting to eighty one. In January, eighteen hundred and seventy-four, a rapid diminution to forty-seven deaths took place, and from the subsequent months to the end of the year a remarkable fluctuation in the mortality was observed, when it began permanently to decline. Fortunately, about this time the vacation in the schools came to the aid of this Board, which had advised, but in vain, their closing; for from this juncture the force of the epidemic was stayed. Scarlatina was, nevertheless, by no means confined to San Francisco, but visited, as seen in Table No. 1, Oakland, Los Angeles, Stockton, and other places, with considerable severity. In Sacramento the progress of the disease was very eccentric, occurring so irregularly and at intervals so remote as to suggest the idea of its sporadic character. At the present writing, how-

ever—June, eighteen hundred and seventy-five—this scourge of childhood, after exhausting itself in San Francisco and the coast towns, seems to be extending its ravages among our interior towns with great malignancy. The uræmic complication appears to be predominant at present, occurring in connection with every form of development of the eruption, angina, or fever. Whether the eruption be intense or moderate, or imperfectly developed, or entirely absent, or it run a protracted or brief and rapid course, the alarming anasarcous symptoms frequently present themselves, and especially in the latter instance. In its present phase, here, the disease has become a terror to parents. The only reliable preventive lies in absolute isolation.

The remaining special diseases it remains for us to consider, in this connection, have been placed in our table (No. 1) under the general term of typho-malarial fevers. In this class, as stated elsewhere in this report, have been included all the varying forms of those fevers supposed to be dependent on one or the same poison—the different grades described by medical writers, from the simple intermittent to the continued and pernicious, bearing a pretty direct ratio to the intensity of the poison. These diseases proved most fatal (32 deaths) in November, and least fatal (5 deaths) in May, which was the healthiest month in the year. Their percentage of mortality to other diseases occurred in the following localities, in the order in which they are respectively named, as follows: Colusa, 15.5 per cent; Marysville, 13.5; Placerville, 11.5; Napa, 7.7; Oroville, 7.2; Siskiyou, 7.1; Stockton, 6.6; Dixon, 5.9; Sacramento, 4.7; Petaluma, 4.4; Folsom, 4.1; Oakland, 3.9; San Francisco, 3.0; Watsonville, 2.2; Redwood, 2.2; Los Angeles, 2.0; and Santa Barbara, 0.9. In San Diego County, Truckee, St. Helena, Santa Cruz, and Downieville, there were no deaths by these fevers. These facts corroborate what was stated in former reports, that the whole State is more or less subject to malarial diseases. They fail, however, to afford a correct idea of the real state of the case in certain localities. For instance, in Oroville, where the mortality is put down to only 7.2, no account was taken of the mortality among the Chinese portion of the population, which, as already stated, was frightful. "The Chinese," according to Dr. Vance, "are scattered from this place down the Feather River, for three and one half miles—in all about seven thousand—mining, almost entirely with the rocker, and more or less naked, and in the water. A few died in the early part of the Summer, but little attention was attracted until August, when they began to die more frequently. I have been at a cabin wherein there would be fifteen to twenty occupants, and one half of them sick with fever—either intermittent, bilious, or typhoid—all of whom could have been cured by proper treatment. I have prescribed for about two hundred, and of these, my druggist says, five have died. A prominent Chinese merchant has just informed me that the dead amounted to about one hundred. The following is the undertaker's list: Deaths in August, 18; September, 23; October, 30; November, 12; add twenty per cent not reported, and we have a mortality of 100."

Dr. P. B. M. Miller, who has published a very interesting account of this epidemic in the "Pacific Medical and Surgical Journal," for January, eighteen hundred and seventy-five, and which he recognizes as similar to the relapsing fever encountered in Ireland, confirms the statements of Dr. Vance as to the predisposing causes. "We have no conception,"

he writes, "of the amount of filth and destitution common to a Chinese hovel; but when we observe their hovels crowded together, the occupants lying on ground nearly a marsh, without any circulation of air, with broken walls of rough timber, forty or fifty half starved human beings in one apartment, generally on bare mats, sometimes on the earthen floor, which is raised a foot or two above a ditch with stagnant and foul water, it is not to be wondered at, that such an epidemic as the one referred to, should break out. Indeed, the 'China towns' of Oroville and Chico are the most offensive, pestilential, nay, abominable, hot-beds of disease in the State. Each of these towns, more especially in the most densely populated parts, is intersected by streets which can scarcely be traversed by two men abreast, and the gutters are merely irregular furrows in the soil, without any brickwork, and are continually left in a filthy and uncleaned state, emitting the most poisonous effluvia."

I have thus dwelt upon the history of this epidemic among the Chinese because it shows how a mild type of malarial fever like that met with in California, may be converted, under certain circumstances, into a grave disease. Like other continued fevers, the specific cause of relapsing fever is unknown; but we know that it selects its victims from the poor and ill fed, who live in crowded and ill-ventilated apartments, and which conditions have obviously favored its accession, and no doubt also its occurrence in an epidemic form, among the Chinese near Oroville. Thus it is spoken of as the famine fever of the British Isles, and the hunger pest of Germany. Knowing the circumstances under which a grave disease, thought by some to be self communicable, has been developed, it becomes incumbent on us to learn the lesson which it teaches, and to provide against its recurrence.

"It would be a blessing to every city," writes Dr. Jarvis, of Massachusetts, "and economy to the body politic, to make these conditions a necessary element in the organic law of every prospective city: to require that its whole plan of streets, lanes, courts, and open grounds be made by a sanitary engineer, and be ever afterward under his control. This would prevent the growth of those centers of disease and death, and those condensed hives of feeble population, that now infest the old cities, and cost the municipalities so much to improve. This is legislation in the right direction, and at the right time, where it would be most effectual. It offers to humanity protection against its sanitary foe before it appears, and disarms it of power to do injury."

Reverting to Table No. 4, we find, in the section containing the ages of all the five thousand eight hundred and eighty-eight decedents, that the greatest mortality occurred in the first decenniad of life, and the lowest in the second decenniad. Less than twenty per cent of the decedents were under one year of age; only thirty-two per cent under five years, and about thirty seven per cent under ten years.

We have already, in our remarks relating to the deaths from diseases of the stomach and bowels, alluded to this comparatively low infantile death-rate as one of the most encouraging and important facts indicative of the salubrity of our climate. Reason for felicitation, in this respect, will be more apparent when we reflect upon the frightful rate of infant mortality all over our country, and especially in our larger Eastern cities, as just referred to in a preceding comparative table of deaths, under two years of age, to each ten thousand population. Excessive heat and improper or tainted food are the casual agents which are accused of taking an active part in the high death-rate of infants in our large Eastern cities. But the Summer temperature,

as shown in our meteorological tables, in San Francisco, is but sixty-one degrees, and only once (in June, eighteen hundred and seventy-four) attained, for a few hours, a maximum of eighty-five degrees. To what cause, then, can we more rationally look for these little graves than to impure air resulting from defective untrapped sewers blowing their foul pestilential vapors through the ill-ventilated houses they were intended to cleanse, or undrained lots or streets made more noxious by the city refuse allowed to accumulate in them? One other possible cause we will barely allude to as quoted from high authority. The unnatural high pressure system under which Americans, and especially Western men, live, can scarcely help showing its exhaustive effects in their offspring. The following suggestive paragraph occurs in the New York *Tribune:*

"The proportion of children among those stricken down by the recent heat was appalling. Yet the heat was not worse than our forefathers bore and lived to tell us of; and it is quite true that the children carried about with them neither exhausting cares in mind, nor too hardly worked bodies, but they had nothing to oppose to the fiery test but flaccid limbs and rasped nerves, bequeathed to them by either liquor-drinking ancestors, or those who make the stimulant of energy and overwork take the place of liquor."

The most healthy period is found in the second decenniad of life, only two hundred and ninety dying between the ages of ten and twenty. Having survived the perils of infancy, the child at this period has fairly entered upon his growth and formation, and at the self-sustaining age of twenty is able to engage in the active duties and responsibilities of life. From this period on to the fiftieth year, or during the next three decades, including the years of labor, exposure, and trial, the largest number died—*i. e.*, two thousand three hundred and eighty-nine, or forty per cent of the total. Having entered on the self-sustaining age at twenty, these persons are supposed to work, or have the chance of working for themselves or the community, until they reach threescore and ten, or to have an offer of fifty working years. But owing to the high-pressure system already alluded to, under which Americans live, the productive life of these two thousand three hundred and eighty-nine decedents was, instead of fifty, only thirty years, and the State lost by their untimely death all the difference between these periods.

After fifty years we find the average ages of the decedents comparing well with those of the healthiest places. It must be remembered, however, that although the average longevity of those who have died is one of the elements in the calculation of the force of mortality, and in the comparison of the health and vitality of different places; yet this must always be taken with much limitation, because the average age at death must bear a relation to the age of the living; and this last differs very widely in different places. A new and growing State like California is filled mostly with adventurers in the prime of life, and has consequently fewer children and aged people than older countries. Therefore, if the proportion of deaths be larger among those in the prime of life, it is for the reason that there are more of these, and less of the young and old to die.

These remarks must not be understood as conveying the idea that more die during the productive ages in California than elsewhere, which is far from being the case; but because such considerations must be applied to all growing cities, towns, and States, when they are compared,

as to their mortality, with other cities, towns, and States that are growing less rapidly, or are stationary.

The last remaining section of our table to be noticed is that under the heading of nativities. Here we find the native and foreign born almost equally balanced, while if we add to the former those born in the Atlantic States, there will remain a difference of about one thousand in favor of the native or American born. It must be remembered, however, that the native element includes the children of native and foreign born as well. The latter are greatly in excess in all our cities and towns, especially in San Francisco; and the Health Officer of this place has compiled from the school census an interesting table bearing on this point. By this we learn that of native children, under seventeen years of age, forty thousand and fifty-six were born of foreign parents, and only twelve thousand two hundred and thirty of native parents, while in five thousand nine hundred and fifty-six the parentage was mixed. Just prior to the close of the year a plan was instituted to ascertain the parentage of deceased minors. The statistics, as yet, are not sufficient to base any comparison upon, but in another year some points of interest may develop:

NUMBER OF DEATHS TO EACH 10,000 INHABITANTS.	San Francisco, 1873-4 (including Chinese).....	New York, 1872.....	Brooklyn, 1873.....	Chicago, 1873.....	Boston, 1873.....	Cincinnati, 1873.....	New Orleans, 1873.....	Buffalo, 1873.....	Providence, 1873.....
Of foreign born.....	92	112	69	76	75	68	95	49	47
Of natives over 5 years.....	41	52	56	21	90	60	141	29	91
Of natives under 5 years ...	67	162	127	142	119	100	122	60	81
Totals.....	200	326	252	239	284	228	358	138	219

Here we see a very great disparity between the different cities. San Francisco, with a low death-rate, has the same number of deaths of foreigners as occur in New Orleans, which has a mortality half as large again; while, on the other hand, New Orleans has over three times as many deaths, relatively, of natives over five years of age. In the absence of statistics of population, however, these comparisons can have very little significance.

To present a more complete showing of all the diseases which have caused the total mortality just discussed, the following statistical tables of the Metropolis and the Capital of California—San Francisco being the type of the coast region, and Sacramento representing the interior valley region—are here superadded.

The tables and remarks for San Francisco have been compiled from the reports of Dr. Henry Gibbons, Jr., the present Health Officer of that city; and the statistics for Sacramento have been abstracted from the records of the City Board of Health.

STATISTICS OF SAN FRANCISCO.

The following table, showing the annual mortality in San Francisco since eighteen hundred and fifty, is reproduced from previous reports. Stillbirths are included up to eighteen hundred and sixty-six–seven:

Year ending June 30, 1851	1,288	Year ending June 30, 1863	2,118
Year ending June 30, 1852	939	Year ending June 30, 1864	
Year ending June 30, 1853	1,619	Year ending June 30, 1865	
Year ending June 30, 1854	1,260	Year ending June 30, 1866	
Year ending June 30, 1855	1,550	Year ending June 30, 1867	2,522
Year ending May 31, 1856	1,226	Year ending June 30, 1868	2,577
Year ending May 31, 1857	1,153	Year ending June 30, 1869	4,093
Year ending May 31, 1858	1,135	Year ending June 30, 1870	3,243
Year ending May 31, 1859	1,254	Year ending June 30, 1871	3,214
Year ending May 31, 1860	1,522	Year ending June 30, 1872	2,998
Year ending May 31, 1861	1,243	Year ending June 30, 1873	3,641
Year ending June 30, 1862	2,051	Year ending June 30, 1874	4,013

Mr. Langley, in the recently issued City Directory, computes the population of San Francisco to be two hundred thousand seven hundred and seventy, which will give a mortality rate equal to about two per cent of the population—a slight increase over the previous year. If, however, we exclude the Chinese (estimated at fourteen thousand five hundred) in this calculation, we have results which may be better appreciated in tabular form, as follows—the facts as to population being derived from the directory and the late school census:

	Population.	Deaths.	Rate per 1,000.
Chinese over 17 years of age	13,214	435	32.9
All others over 17 years of age	127,004	1,943	15.3
Chinese under 17 years of age	1,286	30	23.3
All others under 17 years of age	59,266	1,625	27.4
All others under 5 years of age	21,171	1,310	61.9
All others over 5 years of age	165,099	2,238	13.5
Total Chinese	14,500	465	32.1
All others	186,270	3,548	19.1
Total	200,770	4,013	20.0

TABLE I.

Number of deaths registered during the year eighteen hundred and seventy-four, arranged according to classes, with an enumeration of the more prominent causes, and a statement of the age, sex, and nativity.

Diseases.	Total.....	Per cent.....	Ages.					Sex.		Nativity.				Total — 1873.....
			Under 5 years...	From 5 to 20 years.....	From 20 to 50 years.....	From 50 to 70 years.....	Over 70 years....	Male.....	Female.....	California.....	Other parts of United States..	China.....	Other countries..	
1—Zymotic diseases	845	20.9	441	174	186	39	5	444	401	552	97	9	183	908
2—Constitutional diseases	742	18.4	88	57	490	98	9	499	243	123	143	73	400	699
3—Local diseases	1,436	35.5	446	91	582	260	57	937	499	494	233	14	684	1,441
4—Developmental diseases	477	11.8	353	8	50	21	45	236	241	353	42	5	76	430
5—Deaths from violence	206	5.1	17	14	139	31	3	179	27	26	50	12	111	168
Unknown causes. { Chinese	324	8.0	10	10	274	29	.....	299	25	11	.....	313	.....	307
Unknown causes. { Others	14	.3	4	.....	6	2	1	7	7	3	3	.....	7	49
Total	4,044	.....	1,359	354	1,727	480	120	2,601	1,443	1,562	568	426	1,461	4,002
Percent to total mortality	.....	100.0	33.6	8.7	42.7	11.8	3.0	64.3	35.7	38.6	14.1	10.5	36.1	.....
1—Smallpox	22	.5	3	8	10	1	.....	13	9	6	9	1	6	36
Measles	7	.2	7	.....	.....	.....	.....	3	4	7	.....	.....	.....	60
Scarlatina	255	6.3	160	91	4	.....	.....	119	136	229	17	.....	9	261
Diphtheria	42	1.0	25	16	1	.....	.....	19	23	38	3	.....	1	39
Croup	31	.7	23	8	.....	.....	.....	15	16	29	1	.....	1	30
Whooping cough	18	.4	18	.....	.....	.....	.....	8	10	17	1	.....	.....	70

Typhus and typhoid fevers	122	3.2	19	40	55	7	1	72	50	41	25	.....	56	98
Diarrhea and dysentery	61	1.5	40	7	10	3	1	31	30	39	6	.....	16	55
Cholera infantum	109	2.7	109	.....	.....	.....	.....	53	56	105	3	.....	1	77
Cholera morbus	11	.3	2	1	4	4	.....	5	6	3	.....	.....	8	7
Pyemia and septicemia	19	.4	.....	1	14	3	1	15	4	1	5	1	12	20
Cerebro-spinal meningitis	22	.5	17	3	2	.....	.....	15	7	18	2	.....	2	41
Syphilis	19	.4	2	.....	15	2	.....	10	9	2	4	4	9	16
Alcoholism	51	1.2	.....	1	40	8	2	34	17	2	9	.....	36	38
2—Cancer	85	2.1	3	3	46	27	6	47	38	5	25	5	50	66
Phthisis pulmonalis	556	13.7	19	38	430	66	3	400	156	41	112	69	331	543
Hydrocephalus and tubc. men	53	1.2	42	9	1	1	.....	28	25	46	3	.....	4	52
3—Encephalitis	133	3.3	89	20	17	7	.....	81	52	99	11	.....	23	142
Apoplexy and paralysis	118	2.9	.....	2	56	44	16	84	34	1	28	1	87	67
Convulsions	145	3.6	133	9	3	.....	.....	83	62	135	7	.....	3	121
Other diseases of nervous system	111	2.7	36	12	43	17	3	78	33	44	20	2	45	162
Aneurism	45	1.1	.....	.....	36	9	.....	38	7	.....	8	.....	36	40
Diseases of the heart	179	4.4	2	15	110	38	14	125	54	13	49	.....	115	169
Pneumonia	228	5.6	72	11	92	46	7	154	74	74	43	2	109	226
Bronchitis	48	1.2	22	2	11	10	3	25	23	23	8	.....	17	47
Other diseases of respiratory organs	91	2.2	23	3	45	17	3	57	34	26	12	1	51	121
Disease of stomach and bowels	112	2.8	51	6	38	13	4	73	39	53	9	.....	49	132
Diseases of the liver	79	2.0	4	2	52	20	1	47	32	7	14	1	56	57
Bright's disease and nephritis	36	.9	2	2	20	10	2	28	8	4	6	.....	26	45
4—Puerperal diseases	42	1.0	.....	3	39	.....	.....	.....	42	2	9	1	30	51
Atrophy, inanition, old age	347	8.6	265	5	11	21	45	183	164	266	31	4	45	299
5—Suicides	59	1.5	.....	.....	48	10	1	53	6	.....	24	1	33	48
Deaths in institutions	796	19.7	128	38	464	132	34	625	171	141	138	12	499	702
Stillbirths	.....	.....	.....	.....	.....	.....	.....	179	108	.....	.....	.....	.....	.....

NOTE.—In four cases the age was not given, and in twenty-seven the nativity was unknown.

TABLE II.

Mortality by months, with sex, race, nativity, and distribution, for eighteen hundred and seventy-four.

	Total	January	February	March	April	May	June	July	August	September	October	November	December	Total—1873
Total	1,044	392	301	365	301	295	345	355	337	321	379	320	333	4,002
SEX.														
Male	2,601	259	207	243	197	207	231	197	195	213	241	199	212	2,514
Female	1,443	133	94	122	104	88	114	158	142	108	138	121	121	1,488
RACE.														
Caucasian	3,537	343	246	310	265	244	309	314	302	293	332	286	293	3,488
Mongolian	444	40	48	49	35	43	33	35	29	26	42	32	32	451
African	62	9	7	5	1	8	3	6	6	2	5	2	8	62
Indian	1	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1

NATIVITY.														
California	1,547	139	104	116	93	100	153	175	134	126	166	134	107	1,650
Other parts of United States	582	64	50	44	43	48	42	49	50	50	50	40	52	606
England	143	15	5	13	15	8	17	3	15	11	13	15	13	132
Ireland	620	60	37	62	54	47	49	49	54	50	48	43	67	539
Scotland	48	7	3	7	4	2	2	5	4	2	4	2	6	37
Germany	222	22	15	20	22	15	20	13	19	22	17	15	22	242
France	83	9	6	7	3	8	6	6	7	5	10	8	8	86
Other European countries	197	21	21	21	17	12	7	11	14	18	18	18	19	136
British American Provinces	58	2	4	7	5	9	4	6	7	2	3	3	6	32
South America	13	1	1	2	1	.....	4	.....	.....	1	1	1	1	13
Mexico	42	6	3	8	4	2	5	1	2	5	1	4	1	29
China	424	40	46	47	35	40	31	32	27	26	41	31	28	423
Other countries	35	1	5	7	4	3	3	2	.....	.....	4	4	2	41
Unknown	30	5	1	4	1	1	2	3	4	3	3	2	1	36
DISTRIBUTION.														
City wards	3,043	299	223	282	225	218	262	288	250	240	285	236	235	3,146
City and County Hospital	313	23	22	29	27	22	27	21	22	34	22	30	34	258
United States Marine Hospital	29	2	4	4	1	4	.....	4	.....	2	2	2	4	18
French Hospital	61	6	9	4	1	5	5	4	6	3	8	3	7	51
German Hospital	47	2	5	4	5	6	3	1	5	4	3	4	5	62
Italian Hospital	1	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7
St. Luke's Hospital	15	3	1	.....	.....	1	2	1	3	1	1	2	.....	6
St. Mary's Hospital	130	15	9	12	11	9	9	6	15	11	13	10	10	117
Smallpox Hospital	22	8	2	.....	2	2	2	.....	4	.....	1	....	1	34
Almshouse	35	3	4	4	4	1	6	.....	4	3	2	1	3	46
Other charities	142	9	12	7	7	13	13	12	12	9	19	18	11	92
Casualties	147	16	8	13	12	10	8	12	12	7	18	13	18	117
Suicides	59	6	1	6	6	4	8	6	4	7	5	1	5	48

REMARKS FOR EIGHTEEN HUNDRED AND SEVENTY-FOUR.

San Francisco has just passed through a year of very general healthfulness. But for the prevalence of scarlatina in epidemic form, which is now rapidly disappearing, the smallness of the mortality must have been remarkable. Notwithstanding a period of unusual prosperity and of undoubted large increase of population, the number of deaths in eighteen hundred and seventy-four was but forty-two more than in eighteen hundred and seventy-three. It is computed by those capable of judging, that at least two thousand houses were built in San Francisco in eighteen hundred and seventy-four. It is probable that the increase in population amounts to at least fifteen thousand. In March, eighteen hundred and seventy-four, careful estimates, based on the lists of names in the City Directory, placed the population at two hundred thousand seven hundred and seventy. If we assume this to be the proper average for the year, we have a death rate of twenty per thousand; whilst if we exclude the Chinese from our calculations, the mortality rate among our white inhabitants did not exceed, if it reached, nineteen per thousand.

A glance at the report for eighteen hundred and seventy-three, (1) the increase of population being taken into consideration, will show what a very marked improvement has taken place; and yet the observer will be struck with many points of resemblance in the two mortality tables. In the proportion of deaths from the diseases of the great classes, the differences between the two years are extremely small. Thus, in eighteen hundred and seventy-three there were fourteen hundred and forty-one deaths from local diseases, or thirty-six per cent of all the deaths, while in eighteen hundred and seventy-four there were fourteen hundred and thirty six deaths from these diseases, or 35.5 per cent of the total. The greatest difference between the two years is in the mortality of children under five years of age, and this is in favor of eighteen hundred and seventy-four. In the former year 36.5 per cent of the mortality was of such children, while in the latter, it was but 33.6 per cent, or almost precisely one third of the total. Three per cent of the deaths, in eighteen hundred and seventy-four, were of persons over seventy years of age—a larger rate than prevailed in eighteen hundred and seventy-three. The great disparity in the number of male and female decedents still exists as it existed years ago, but the ratio of males is surely though gradually diminishing. Thus, in eighteen hundred and sixty-one and eighteen hundred and sixty-two, of every hundred deaths, sixty-seven were males; in eighteen hundred and sixty-six, eighteen hundred and sixty-seven, and eighteen hundred and sixty-eight, from sixty-five to sixty-six were males; while in eighteen hundred and seventy-four the males numbered but little over sixty-four in the hundred, which was slightly more than in eighteen hundred and seventy-three. It will be seen, however, that as regards the decedents from zymotic diseases, our table shows an almost equal mortality of the two sexes, while in several instances, as measles, scarlatina, diphtheria, croup, whooping cough, etc., the preponderance is actually in favor of the females. This may be partially explained when it is recollected that

(1) The totals for eighteen hundred and seventy-three have been added in the right hand column of both tables.—Sec. State Board of Health.

the vast majority of deaths from zymotic causes occurs among young children.

As regards nativity of decedents, we note that 38.6 per cent were born in California, and that only fourteen per cent, or less than one seventh, had their birth-place in other portions of the United States. On the other hand, about forty-seven per cent, or nearly one half, were foreign born, and of these, over a fifth were Chinese, and about one third Irish.

Turning to individual diseases, we observe that there were twenty-two deaths from smallpox, most of them natives of the United States, and half of them under twenty years of age. This disease has now entirely disappeared from San Francisco, no death having occurred for several months, and the only case for a length of time being one that arrived overland from St. Louis. Scarlatina caused five hundred and sixteen deaths in the two years eighteen hundred and seventy-three and eighteen hundred and seventy-four, during which it proved as severe an epidemic of this disease as ever visited our city. Nearly all the decedents were under ten years of age, and two thirds were under five years of age. As was to be expected, they were, with few exceptions, natives of California. A material decrease in the number of deaths from diphtheria, croup, and whooping-cough occurred in eighteen hundred and seventy-four, but from cholera infantum there were nearly half as many more. Typhoid fever was also more fatal; and precisely one half of the deaths (sixty-one) occurred in four months—August, September, October, and November.

The actual increase in the number of deaths reported from consumption is very small; in fact, but thirteen. It will be seen, however, that the native-born decedents have largely diminished, and the foreign as largely increased. Just four hundred, or nearly three fourths of the deaths, were of foreigners. Precisely the same number were males. From pneumonia there was an average mortality of precisely nineteen per month, two thirds being males and about one half foreign born. If we associate all diseases of the respiratory system under one head, we have a total of nine hundred and twenty-three deaths, or nearly one fourth of the entire number; and of these nearly two thirds were between the ages of twenty and fifty years.

The number of deaths in public and private institutions was large, but when it is remembered that there were treated in them over seven thousand patients in eighteen hundred and seventy-four, and that about seven hundred patients are constantly beneath their roofs, it will not be considered excessive. If we exclude those under five years of age, nearly all of whom were in fact but a few weeks or months old (foundlings), the foreigners comprise over seventy-five per cent of all dying in the hospitals, showing what class patronizes these institutions. Let it be understood, however, that about one third of the deaths occurred in the private hospitals, such as the St. Mary's, the French, and the German, where patients are required to pay for their care, and hence are not charity patients.

During the latter half of eighteen hundred and seventy-four, a record of the nativity of parents of minors was kept. From this it appears that in the seven hundred and sixty-six instances in which the facts were given, only one hundred and twenty-three decedents had native-born parents; five hundred and sixty-seven had foreign-born parents; and in seventy-six cases the parentage was mixed. This is simply another proof of the great preponderance of the foreign element.

The deaths from violence were considerably in excess of the number in eighteen hundred and seventy-three. The number of suicides was greater, and probably San Franciscans have not forgotten the extraordinary number of homicides (twenty-seven), most of which occurred early in the year. These served in the main to make the increase in fatal casualties over eighteen hundred and seventy-three. Finally, a few more stillbirths were reported in eighteen hundred and seventy-four, the males as usual being in excess.

VITAL STATISTICS OF SACRAMENTO.

ESTIMATED POPULATION, 1874.

	Inhabitants.
The City Directory gives the names, over twenty-one years of age, of	7,000
The school census enumerates children under seventeen years of age	5,821
Females over seventeen years of age not enumerated in either directory or school census	5,000
Males between seventeen and twenty-one years of age not enumerated in either directory or school census	1,500
Chinese, Negroes, and Indians, not enumerated in either directory or school census	1,679
Total permanent population of Sacramento	21,000

Months.	Birth-rate.			Death-rate.		
	Males.	Females.	Total.	Males.	Females.	Total.
January	13	12	25	13	9	21
February	12	13	25	21	14	35
March	16	7	23	20	15	35
April	4	10	14	15	9	24
May	10	9	19	13	7	20
June	9	11	20	17	8	25
July	11	11	23	16	8	24
August	14	8	22	18	10	28
September	14	10	24	14	7	21
October	14	19	33	19	7	26
November	18	9	27	17	8	25
December	16	9	25	21	7	28
Totals	151	128	279	204	109	313

The records of all times and places establish, beyond question, that the causes which determine a low death-rate tend likewise to determine a high birth-rate. The exceptions occasionally found to this law owe their existence to the fact that some cause of death is particularly active amongst the unproductive members of the community. As, for example, measles, or any other disease of childhood, may increase the death-rate to a very decidedly larger figure without sensibly affecting the birth-rate. But this is generally a temporary cause, as affecting the death-rate, and does not invalidate the rule, that the birth-rate is in inverse ratio to the death-rate; the lower the latter, the higher the former. As no exception has occurred to interfere with the operation of this law in Sacramento, we conclude that the ordinance requiring returns of births to the Health Board, as shown in the comparatively low birth-rate, has, like our State registration laws, been only partially complied with.

ANNUAL TABLE OF THE NECROLOGY OF SACRAMENTO FOR EIGHTEEN HUNDRED AND SEVENTY-FOUR.

CAUSES OF DEATH.	Total	Months.												Sexes		Ages.								Nativities.		
		January	February	March	April	May	June	July	August	September	October	November	December	Males	Females	Under 1 year	1 and under 5	5 and under 10	10 and under 20	20 and under 30	30 and under 40	40 and under 50	50 and under 60	60 and under 100	Unascertained	Pacific States	Atlantic States	Foreign countries
I.—GENERAL DISEASES.																										
General Diseases, A—																										
Smallpox	1	...	...	...	...	...	...	...	1	...	...	...	...	1	...	...	...	...	...	...	...	1	...	...	...	1	...
Scarlet Fever	10	...	2	1	...	...	...	...	3	...	...	2	2	7	3	...	6	...	...	1	...	...	...	...	6	3	1
Cerebro-spinal Fever	3	1	...	...	...	...	...	...	1	...	...	...	1	3	...	...	...	...	...	1	...	...	...	...	1	1	1
Typho-malarial Fever	15	1	1	1	...	...	1	1	2	1	2	...	3	12	3	...	...	...	2	4	1	...	...	...	1	3	11
Pyæmia	3	2	...	...	...	...	1	...	...	...	...	...	...	3	...	...	...	...	...	1	1	...	1	...	...	2	1
Fever, Puerperal	1	1	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	1	...	...	...	...	...	...	1
General Diseases, B—																										
Syphilis	1	...	...	...	...	...	1	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	1	...	...	...	1
Cancer	6	...	...	1	1	...	1	...	...	2	...	1	1	3	3	...	...	...	...	...	1	4	...	...	...	3	3
Consumption	53	4	6	7	5	4	5	3	5	2	4	3	5	36	17	...	...	1	8	18	15	9	2	...	7	21	25
Anæmia	2	...	...	...	...	...	1	1	...	...	...	...	...	1	1	...	2	...	...	...	...	...	...	...	2	...	...
Dropsy	6	...	...	1	1	1	1	...	...	...	...	2	...	4	2	...	...	...	1	2	1	...	2	...	...	3	3
II.—LOCAL DISEASES.																										
Diseases of the Nervous System—																										
Meningitis	20	1	2	1	1	4	4	1	...	2	3	...	1	12	8	5	6	5	...	...	1	2	1	...	12	7	1
Apoplexy	6	...	...	2	1	...	2	...	1	...	...	...	...	4	2	...	...	...	...	...	...	2	1	...	...	4	2
Paralysis	4	...	...	1	1	1	...	...	1	...	...	...	...	2	2	...	...	...	...	...	...	...	2	...	...	1	3
Convulsions	13	3	1	2	...	...	1	1	...	4	1	2	...	8	5	5	7	1	...	...	...	...	...	...	13	...	...
Other diseases of this group	4	...	1	1	...	...	...	...	...	...	1	1	...	3	1	...	...	...	...	...	...	...	3	1	...	...	2
Diseases of the Circulatory System—																										
Heart, Disease of	13	...	4	1	2	2	...	...	...	1	1	...	1	8	5	...	...	...	1	3	5	2	1	1	...	11	2
Cyanosis	2	...	...	...	...	...	...	...	...	1	1	...	...	1	1	2	...	...	...	...	...	...	...	...	2	...	...
Aneurism	4	...	1	...	...	...	...	...	2	...	...	...	1	4	...	...	...	...	...	1	1	...	...	1	...	...	4
Diseases of the Respiratory Organs—																										
Laryngitis	1	...	...	1	...	...	...	...	...	...	...	...	...	1	...	...	1	...	...	...	...	...	...	...	1	...	...
Bronchitis	3	...	...	...	...	...	...	...	1	...	...	...	2	...	3	1	2	...	...	...	...	...	...	...	3	...	...

Pneumonia	21	2	3	5	3	1	...	2	1	1	1	2	...	11	10	...	5	2	1	1	2	5	3	2	...	8	6	7
Hæmoptysis	2	...	1	...	..	...	...	...	...	...	...	1	...	2	.....	...	1	...	...	...	...	1	...	...	...	1	...	1
Other diseases of this group	10	...	2	2	1	...	...	...	2	...	1	1	1	7	3	3	1	...	1	1	1	...	2	1	...	5	1	4
Diseases of the Digestive System—																													
Gastritis	7	1	2	1	...	...	2	...	1	...	...	...	...	5	2	2	2	1	...	...	1	1	...	...	...	5	...	2
Enteritis	4	...	1	...	...	1	...	...	...	...	2	...	...	2	2	2	1	...	...	...	...	...	...	1	...	3	1	.....
Dysentery	4	...	...	...	...	...	...	2	...	1	...	...	1	2	2	1	...	...	...	2	1	...	...	...	...	2	2	.....
Diarrhœa	3	1	...	...	...	...	...	1	...	...	...	1	...	1	2	3	...	...	...	...	...	...	...	...	...	3	...	.....
Cholera Infantum	1	...	...	...	...	...	...	1	...	...	...	...	...	1	.....	...	1	...	...	...	...	...	...	...	...	1	...	.....
Hernia	2	...	...	...	...	...	...	...	1	1	...	...	...	2	.....	...	...	...	...	...	...	1	1	...	.....	1	1	
Other diseases of this group	5	...	...	1	...	...	1	...	...	...	2	1	...	4	1	1	...	...	...	...	1	3	1	...	...	1	1	3
Diseases of the Urinary System and of the Male Organs of Generation—																													
Bright's Disease of the Kidneys	7	...	...	...	...	...	1	2	...	..	2	1	1	5	2	...	...	1	3	1	2	...	...	...	...	1	2	4
Diseases of the Female Organs of Generation—																													
Diseases of the Uterus	1	...	...	...	...	...	...	...	...	...	...	1	...	.....	1	...	...	...	...	...	...	1	...	...	...	.....	1	.....
Metro-peritonitis	3	...	...	...	...	...	...	1	1	...	...	...	...	.....	2	..	...	...	...	1	1	...	...	...	...	.....	2	.....
Affections connected with Pregnancy—																													
Abortion	1	...	...	...	...	...	...	...	...	...	1	...	...	.....	1	...	...	...	...	1	...	...	...	...	...	.....	...	1
Puerperal Convulsions	2	...	...	...	...	...	...	...	...	2	...	...	...	.....	2	...	...	...	...	...	...	...	...	...	...	.....	...	.....
Diseases of the Organs of Locomotion—																													
Diseases of the Bones	1	...	...	...	...	1	...	...	...	...	...	...	...	1	.....	...	...	...	1	...	...	...	...	..	...	.....	...	1
Diseases of the Integumentary System—																													
Abscess	1	...	...	1	...	...	...	...	...	...	...	...	...	1	.....	...	...	..	...	...	1	...	...	...	...	.....	...	1
III.—CONDITIONS NOT NECESSARILY ASSOCIATED WITH GENERAL OR LOCAL DISEASES.																													
Stillborn	24	6	1	1	1	3	1	...	1	2	3	2	3	16	8	24	...	...	...	...	...	...	...	...	...	24	...	.....
Old Age	4	...	1	1	1	...	...	...	...	1	...	...	...	2	2	...	...	...	...	...	...	...	...	4	...	.....	2	2
Debility	15	1	1	2	2	1	1	2	1	...	1	1	2	10	5	7	3	1	...	...	...	2	1	1	...	11	2	2
Premature Birth	5	...	1	...	1	...	2	1	...	...	...	...	...	4	1	5	...	...	...	...	...	...	...	...	...	5	...	.....
IV.—POISONS.																													
Alcohol	4	1	...	...	1	...	...	...	1	...	1	...	...	3	1	...	...	...	...	...	1	1	2	...	...	.....	2	2
Poison not specified	2	...	...	...	...	...	...	1	...	1	...	...	...	1	1	...	1	...	...	1	...	...	...	...	...	1	...	1
V.—PARASITES.																													
Worms	1	...	...	...	...	...	1	...	...	...	...	...	...	1	.....	...	1	...	...	...	...	...	...	...	...	1	...	.....
VI.—MALFORMATIONS.																													
Malformations	1	...	...	...	...	...	...	1	...	...	...	...	...	.....	1	1	...	...	...	...	...	...	...	...	...	1	...	.....
VII.—ACCIDENTS AND INJURIES.																													
Drowning	7	1	1	...	...	...	...	2	1	...	1	...	1	7	.....	...	...	...	1	2	2	...	2	...	...	1	...	6
Gun-shot Wounds	1	...	...	...	...	...	...	1	...	...	...	...	...	1	.....	...	...	...	...	...	...	..	1	...	...	.....	...	1
Other Wounds	1	...	1	...	...	...	...	...	...	...	...	...	...	1	.....	...	...	...	...	...	...	1	...	...	...	.....	...	1
Railroad Accidents	2	...	...	...	...	...	...	...	...	1	...	...	1	2	.....	...	...	...	...	1	...	...	...	1	...	.....	1	1
Other Accidents	3	...	...	...	2	1	...	...	...	...	...	...	...	1	2	...	...	2	...	...	...	1	...	...	...	1	2	.....
Suicide	5	...	...	...	1	...	...	...	...	1	1	1	1	4	1	...	...	...	...	...	2	2	...	1	...	.....	4	1
Unknown Causes	16	2	3	2	...	2	...	...	2	1	...	2	2	13	3	3	1	...	1	...	2	3	2	2	2	5	...	11
Totals	337	28	36	36	25	23	26	24	29	23	29	27	31	225	112	71	37	16	23	42	53	41	24	27	3	131	92	114

MONTHLY AND ANNUAL MORTALITY OF SACRAMENTO,

From the founding of the city to the present time—a period of twenty-five years.

Months.	1850.	1851.	1852.	1853.	1854.	1855.	1856.	1857.	1858.	1859.	1860.	1861.	1862.	1863.	1864.	1865.	1866.	1867.	1868.	1869.	1870.	1871.	1872.	1873.	1874.
January	.....	37	19	44	37	81	27	17	24	27	47	42	34	35	35	30	23	25	34	49	47	28	20	31	22
February	.....	36	21	29	16	17	32	11	17	15	32	29	33	25	24	23	20	21	25	38	30	24	26	29	35
March	.....	21	23	21	23	19	16	16	25	24	26	21	33	27	29	27	26	28	21	38	26	31	21	30	35
April	10	22	18	28	12	16	30	23	22	18	35	29	24	22	44	22	19	28	22	43	23	24	25	31	24
May	22	13	20	20	16	17	25	29	31	19	37	22	29	26	41	22	29	27	27	41	36	38	26	37	20
June	30	13	29	18	19	20	26	24	27	22	33	20	23	30	38	20	28	24	56	33	36	26	40	33	25
July	31	15	45	15	20	17	28	22	17	32	41	24	36	26	26	33	27	20	58	31	31	28	37	26	24
August	47	15	77	41	20	26	35	34	24	26	22	33	23	30	27	29	19	20	42	35	31	28	19	39	28
September	57	20	185	9	20	22	25	22	24	24	28	26	22	32	56	34	30	24	32	39	29	34	34	24	21
October	325	21	79	37	32	31	45	23	34	31	39	37	34	35	33	53	38	26	35	48	50	32	35	46	26
November	326	28	76	31	27	33	23	42	30	30	45	40	34	45	41	38	28	19	53	57	46	27	28	35	25
December	52	39	43	40	23	26	21	25	27	39	51	37	25	49	32	27	29	25	39	43	33	24	41	32	28
Totals	900	280	635	333	265	324	333	288	302	307	436	361	353	380	426	358	316	287	444	485	418	344	352	403	313

In 1850 and 1852, Asiatic cholera was epidemic. In 1855, of the 81 deaths in January, 65 were caused by the explosion of the steamer Pearl. In 1860, scarlatina and diphtheria prevailed epidemically. In 1864, the explosion of the Washoe swelled the mortality. In 1868–9, smallpox was epidemic.

Population, 21,000. Ratio of deaths per 1,000 of the population, or death-rate, 14.9, in 1874. Stillborn not included.

HOSPITALS, ASYLUMS, PUBLIC INSTITUTIONS, ETC.

Among other requirements of the organic law, it is directed that "the State Board of Health shall place themselves in communication with the Local Boards of Health, the hospitals, asylums, and public institutions throughout the State, and shall take cognizance of the interests of health and life among the citizens generally. They shall make sanitary investigations and inquiries respecting the causes of disease, especially of epidemics, the sources of mortality, and the effects of localities, employments, conditions, and circumstances on the public health; and they shall gather such information in respect to these matters as they may deem proper for diffusion among the people."

In the discharge of the different duties here set forth, which naturally interlock with each other, and refer to subjects of which a competent knowledge is necessary in order to advisement as to the state of the population in health and disease, and as to unwholesome conditions and their abatement, I would here refer to the action which has been taken with regard to our County Hospitals, and which will be best explained by the following circular:

OFFICE STATE BOARD OF HEALTH,
SACRAMENTO, August 15th, 1874.

To the Supervisors and Hospital Physicians of the various counties in the State:

Complaints having reached this office of the generally faulty condition and mismanagement of our County Hospitals, I have been instructed, by a resolution of the Board I represent, to inquire into the matter, and to adopt such measures as the circumstances of the case may, in my judgment, seem to require. Acting upon this authority I have deemed it proper to submit this circular to the consideration of Supervisors, Physicians, and all others interested.

From the inquiries instituted it appears that the causes of complaint are found, not only in the structural and dietetic provisions of these hospitals, but also in their medical administration. In several instances the indigent sick are let out, *per capita*, to the lowest bidder, to provide hospital accommodations, nursing, diet, medical attendance, and medicines. That such a system of economical provision for the sick must necessarily lead to great abuses, and defeat the beneficent object for which these hospitals are designed, the facts of the case, as far as I have been able to ascertain, clearly establish. In one instance, to which my personal attention was recently called, the rented house, used as a County Hospital, was found to be old, dilapidated, and without ventila-

tion, save nine little windows, in all, distributed in the six small rooms, into which the building was divided up, and which did not afford one fourth of the *absolutely* requisite surface-area for the twenty-six patients crowded therein. The feeding, nursing, medical attendance, and medicines were also furnished by the contract system. On remonstrating with the Supervisors, who gave me a hearing at a subsequent visit, in compliance with the request of the County Physician—these officials, I am now happy to say, soon became convinced of the impropriety of the system that had been pursued. Besides promising reform in the general administration of hospital matters, they fully authorized me to have such building plans and instructions prepared, as I might deem necessary for the proper care of the indigent sick, at the expense of the county. Believing that the case cited is one among many, in which the same grievances obtain, and which a little exertion on the part of the physicians and all others interested, is calculated to redress, I have thought it expedient to present briefly the arguments then adduced, in connection with other matters, which the object of this circular suggests.

It is taken for granted that the reason for the establishment of County Hospitals is that, by aggregation, the sick may be restored to health at a minimum cost, because of the relatively small number of nurses, physicians, and other attendants that suffice for their care and treatment. Now the principles which underlie this proposition, both from an economic and humane point of view, and to the enforcement of which all other considerations should be subservient, exact, that the sick shall be, by this means, restored to health as speedily as possible, and, above all, that the hospital shall do the sick no harm. This latter condition, which was first enunciated by Florence Nightingale, several years ago, is predicated upon the fact, that it not unfrequently occurs that patients enter hospitals with simple diseases, or trivial injuries, and contract therein other, and more lingering maladies, of which they often die. Thus the efficiency of a hospital is found, not in the large proportion of sick restored to health, but in the average time that has been required for this object. A hospital which restored all its sick to health after an average of three months' treatment, cannot be considered so well adapted to its purpose as a hospital which discharged all its sick recovered in as many weeks. Besides this test, sanitarians and others who have devoted their attention to hospital reform, maintain that the origin and spread of diseases in a hospital, such as typhoid fever, erysipelas, hospital gangrene, and pyæmia generally, are much better proofs of the defective qualities of a hospital proper, than its statistics. The defects, to which such accidental diseases are attributable, are found to consist in unfavorable sites, improper plans, bad sewerage, want of ventilation, and overcrowding; and it is to these important points, on which the efficiency of all hospital treatment depends, that I wish to call special attention. The wards of a hospital are unlike every portion of an ordinary dwelling, occupied day and night, inasmuch as the usual excretions, which are constantly escaping from the system through the lungs and skin, and which even in health are deleterious elements, become in disease more actively and even specifically poisonous. Suppurating surfaces throw into the air pus-cells in a state of decay—special diseases give out their special poisons, while the fæcal and urinary discharges, from so large a proportion of persons, add their foul influence to the decomposing organic matters, and make them still more dangerous.

The result of all this is that a pernicious atmosphere accumulates, which, if not continuously and rapidly removed by adequate ventilation,

sewerage, and cleansing, soon pervades every part of the building, and after a longer or shorter period—depending upon the amount of air-space to each patient, and the ventilation and cleanliness observed—the floor, walls, furniture, and bedding become saturated with a miasm, which is capable of poisoning a large percentage of the inmates, and which, if it does not inflict other diseases than the one for which they were admitted, at all events lowers the vital force and prolongs the original malady.

Now we have reason to apprehend that most of our County Hospitals, which have been constructed without a thought as to site, drainage, ventilation, or the prerequisite cubic space of air to each patient, are precisely in a condition presenting all the dangerous qualities just alluded to. From such considerations, and in accordance with the advanced views of those who have studied the subject of hospitalism, it becomes imperiously necessary to provide a radical remedy—and that remedy consists in the abandonment of all contaminated hospitals—in fact, of all hospitals which have been in service more than ten years, and the construction of entirely new buildings, with all the essential requirements. Fortunately, it so happens, as an additional incentive to the accomplishment of this end, that the most economical mode of hospital construction has proved to be the safest for the sick. What is now the so-called pavilion hospital, built entirely of wood, and calculated for only ten or fifteen years use, is everywhere superseding the substantial and costly hospitals which were wont to be built as "monuments for all time" of a charitable community.

Without extending these remarks to an inappropriate length at this time, and inasmuch as it is proposed to publish in the next biennial report of this Board full instructions, illustrated by plans, for the construction and arrangement of the kind of hospital here advocated, I will simply refer to the recently erected City and County Hospital of San Francisco, as an example. A plan, conforming in all essential particulars to this pavilion hospital, which is built of redwood, has been adopted by the Supervisors of Solano County, consisting of two detached wards of one story in height, capable of accommodating twenty-six patients, and connected by an open piazza with the appropriate offices and other rooms, which, when constructed, will not cost over eight thousand dollars. The architect, Mr. A. A. Cook, of Sacramento, who has prepared this plan under my immediate supervision, will modify it to accommodate any number of patients, be it more or less, if called upon to do so, at a very moderate charge. I respectfully urge this method upon the attention, especially of all our county physicians, as one dictated by every humane consideration, and calculated to do justice as well to the sick and suffering as to their medical treatment. To facilitate the procurement of statistics, on which to predicate an opinion as to the sanitary conditions and remedial results of each hospital, suitable blank forms have been prepared, which it is requested will be returned, properly filled out, quarterly, to this office.

THOS. M. LOGAN, M. D.,
Permanent Secretary State Board of Health.

In accordance with the views above expressed, a few only of the counties have adopted the plans suggested. In order to expedite the action of others, I have caused the accompanying plans and instructions to be prepared by a competent architect (Mr. A. A. Cook), which, it is hoped, will accomplish all the objects for which they were designed.

CONSTRUCTION OF HOSPITALS, ILLUSTRATED WITH PLANS.

The causes which render a badly constructed hospital unhealthy, are due to those natural influences which are continually at work in the body, suffering from disease, to restore it to the normal condition of health. The lungs and skin are two great channels through which constantly escape from the system, even in health, the most deleterious or poisonous elements. In disease these emanations become more actively, and even specifically poisonous; hence a number of patients congregated in a common ward generate a miasm which accumulates, if not rapidly removed by adequate ventilation, until every part of the room is pervaded, and after a longer or shorter period, depending upon the persistency and degree of cumulation, the floor, walls, furniture, and bedding of the ward become saturated with a miasm which is capable of poisoning a large percentage of those who are exposed to its influence.

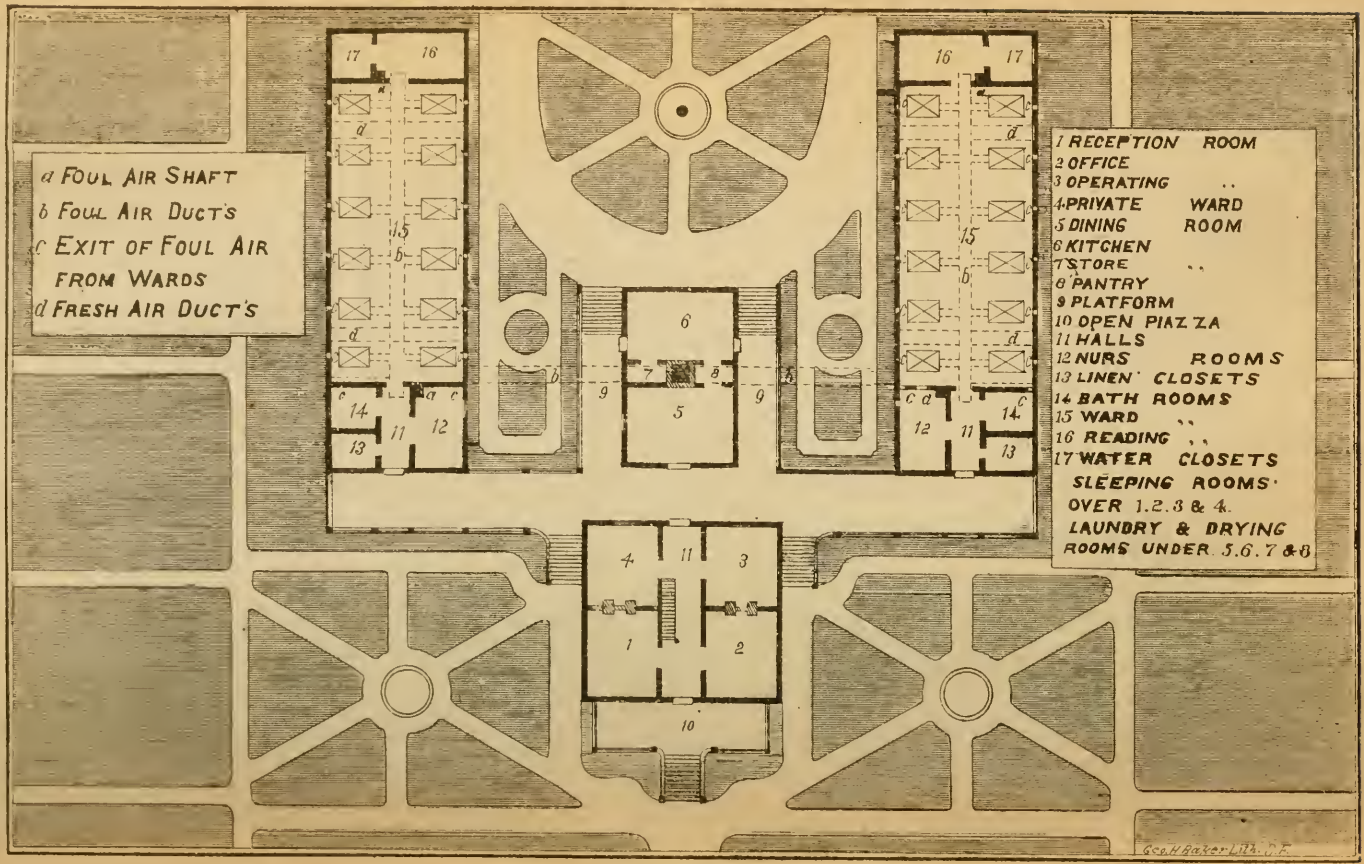
It is believed that the evils above mentioned may be avoided, by conforming to the following general system of construction and disposition of hospitals on the pavilion plan and heated-shaft system of ventilation. Two designs (Plates I to IV) are here presented for two small frame hospitals, on the pavilion plan, which were expressly prepared for this report, and will serve as an illustration in the following discussion of hospital construction.

The site should be free from nuisances of every kind, abundantly supplied with pure fresh water, sufficiently elevated to insure good surface and subsoil drainage, and isolated to an extent sufficient to give the necessary exposure to currents of air. The hospital proper should consist of pavilions or separate detached buildings (Plates I and II), one story in height preferable, and of simple architectural design, constructed with the view of destroying them, so soon as the peculiar hospital diseases, erysipelas, pyæmia, gangrene, etc., are engendered by the cumulated miasm of the patients: a condition which usually obtains after the continued use of a ward for ten or fifteen years—the time depending mainly upon the amount of air-space to each patient and the character of the ventilation. A pavilion hospital with two floors (Plates III and IV) is not seriously objectionable, provided the system of ventilation is distinct for each floor.

There should be but one ward to a floor; cross-walls or partitions obstruct the ventilation, and the only plan in which two wards on one floor are admissible, is where the administrative offices and stairways to the upper wards are in the center of the building, with access to the wards right and left (Plate III).

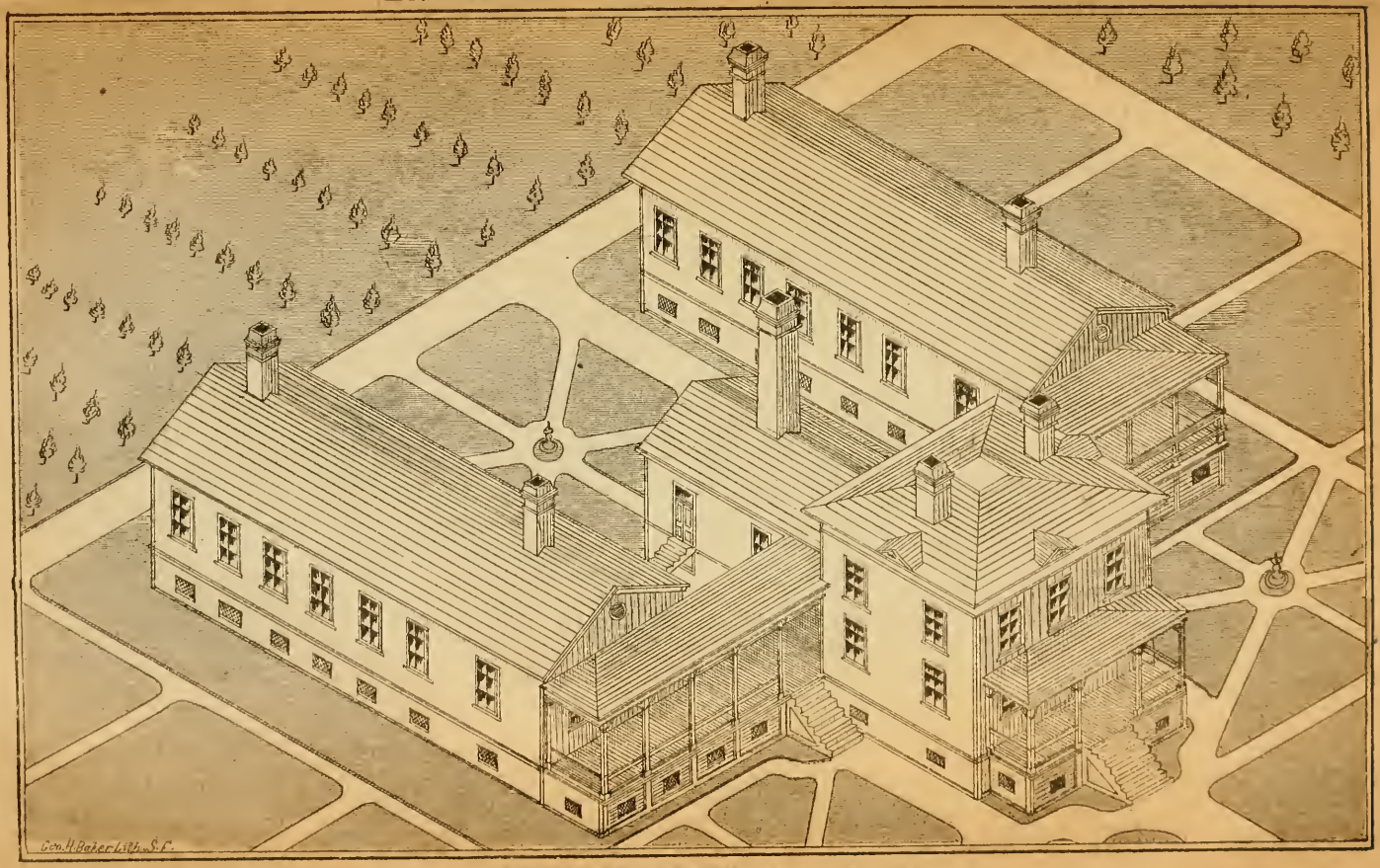
Wood is preferable in the construction, framed in balloon style, covered outside with rustic, and well painted, and have shingled roofs; the floors should be at least six feet above the ground, made of hard close-grained wood, such as cherry, ash, or Mendocino pine, laid with lead paint in the joints, and the top surface should have one or two coats of oil and wax to prevent the floors from absorbing moisture. The interior walls and ceilings may be plastered and left in the sand finish, painted and varnished, or lined with building paper over the framework, and have one or two coats of varnish; the latter is only about half the expense of plastering, and answers every purpose. White hard finish

PAVILION HOSPITAL PLATE I



FLOOR PLAN

PAVILION HOSPITAL PLATE II



ISOMETRICAL VIEW

in plastering never should be used in hospital construction. The inside wood work of a ward should be very plain, so as to be easily cleaned, and should always be varnished.

The executive building should be centrally located, so as to admit of easy and rapid communication with the other buildings, and contain the surgeon's office, reception room, operating room, and private ward, etc. The second or third story can be used for sleeping apartments for the stewards, apothecary, matron, etc.

The kitchen building should be separated from the executive and ward buildings with an open piazza or well-ventilated corridor. The basement of this building can be used for the laundry, mending and ironing rooms, etc., and should have a well-constructed shaft or chimney erected in the center of the building, and all the smoke and waste heat should be conveyed into this shaft for ventilation of the entire buildings.

The ward buildings should be arranged on parallel or radiating lines running north and south, thereby securing the morning and evening sun to the patients. Plate I and II is arranged to either face the north or south, and Plate III and IV is arranged to face either the east or west; and either design will secure the morning and evening sun to the patients. Small wards are necessary in connection with a hospital, for the purpose of isolating certain patients; but such wards should be independent of the large ones, if possible. The windows of a ward should be opposite to each other, and the top sashes should be hung on weights, and have closely fitted frames covered with fine wire netting, to be used for Summer ventilation, when desired. It is better to keep the windows closed when the mode of ventilation herein described is properly constructed.

The principal nurses' rooms should be placed near the entrance of the ward, and provided with a window which commands a view of its entire length. The linen closets should be near and accessible to the nurses' room.

The bath room should be separated from the ward by a well-ventilated passage, and supplied with bath-tub for hot and cold water, sitz and steam bath, and porcelain wash-basins.

It is desirable to have a room connected with each ward, where the patients, who are able to leave their beds, can sit during the day to read and smoke.

The water-closets should be separated from the passage to the ward by a door fitted to swing both ways, which should always remain closed when not in use. The basins should be well supplied with water, and have strong traps, and the seats should be arranged with close-fitting covers.

The sink for ward slops, etc., should be in the same department with the water-closets. In order to insure the most perfect ventilation possible, there should be a chimney or exhaust shaft erected (*a*. Plate I and III), of sufficient capacity to remove all the foul air from the various rooms in the building, and inside of this shaft there should be a sheet iron pipe, to extend the entire length, and the smoke and waste heat from the kitchen, laundry, etc., should be conveyed into this pipe, which will raise the temperature of air in the shaft, and make it pass off very rapidly. There should be air-tight horizontal tubes (*bb*. Plate I and III) laid from the ventilating flue of this shaft to each ward or room to be ventilated, terminating in openings (*cc*. Plate I and III) through the floor or baseboards. In addition to this exhaust shaft or chimney, there

should be open fireplaces or grates provided in the executive building, and open grates, or flues for heaters, provided at each end of the wards, with openings at the bottom of the room, near the floor.

The hospital should be warmed by passing an abundance of pure fresh air through a hot air furnace or over coils of steam pipes placed in the basement, having tubes or ducts terminating with registers in the floor, at the furthest point possible from the foul-air openings.

For Winter ventilation, the fresh air should be moderately warmed before being admitted into the wards; and in Summer, the fresh air should be cooled, by either placing ice or buckets of fresh water in the tubes or ducts, thereby producing abundance of evaporation, cooling the air, and supplying the proper degree of watery vapor.

This method of natural-forced ventilation is extremely simple, when properly understood, and fully meets the requirements demanded, without producing any unpleasant draughts; and the extra cost of the shaft, tubes, etc., is but a few dollars more at most, than if there was no ventilation provided.

The drainage should be underground, and all inlets to the sewers should be properly trapped, and no drain should pass under the buildings. Care should be taken that no fresh air flue should open near the sewers.

The following is an explanation of the plans here presented, reference to the figures on each plan being the same, which could be either enlarged or reduced in size to suit the requirements demanded for such a building, simply giving a general idea of a pavilion hospital:

EXECUTIVE BUILDING.

No. 1 is the reception room; 2, office, and each is 12x15 feet; 3, operating room and laboratory; 4, private ward, and each is 12x14 feet; this story is 12 feet high; 11, hall, with stairs leading to the basement and second stories, where the general stores, water-closet, and dead-room are in the former, and sleeping rooms, closets, etc., are in the latter.

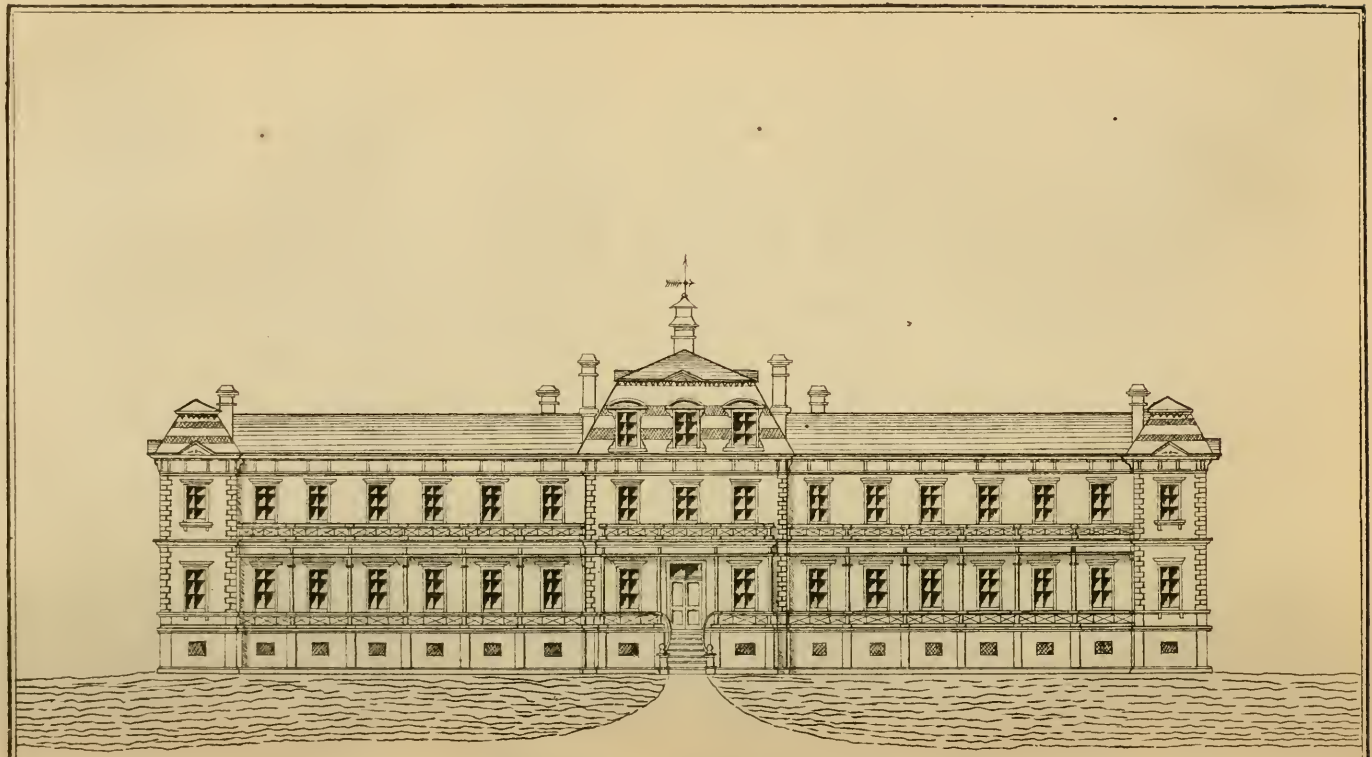
REAR BUILDING.

No. 5 is the general dining room, 15x22 feet; 6, kitchen, 14x22 feet; 7, kitchen stores, 5x9 feet; 8, dish pantry, 5x9 feet; the laundry, ironing, and mending rooms may be arranged in the basement story of this building; 9, platform, with steps on each side of the kitchen; 10, open piazza, 12 feet wide, and extending to all of the buildings, with steps, etc., on each side of the executive building.

WARD BUILDINGS.

No. 11 is the passageways, 6x15 feet; 12, nurses' rooms, 11x15 feet; 13, linen closets, 6x9 feet; 14, bath rooms, 8x9 feet; 15, ward rooms, 25x50 feet, and 16 feet high; 16, smoking and reading room, 10x17 feet; 17, ward water-closets, 8x10 feet.

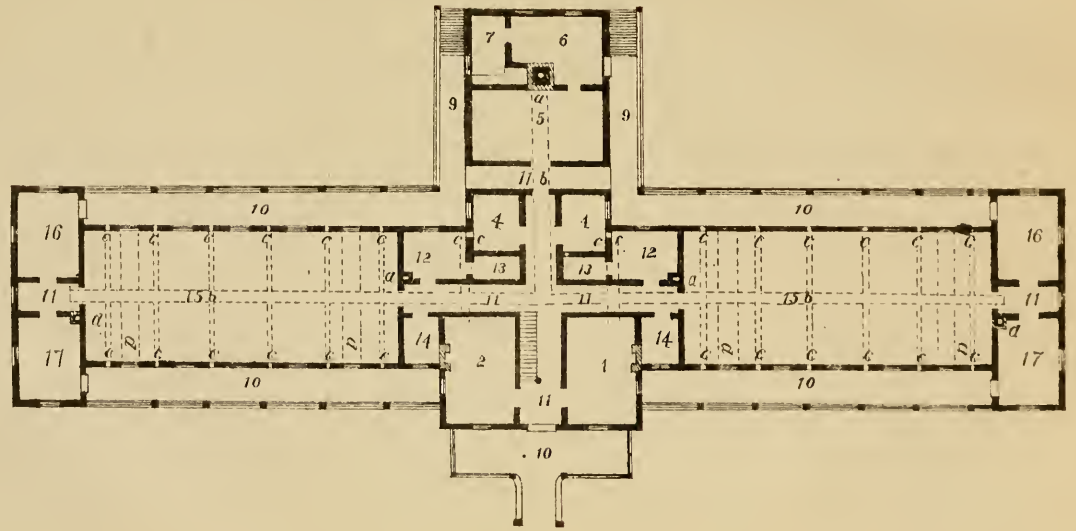
PAVILION HOSPITAL PLATE IV



FRONT ELEVATION

Geo. H. Baker Lith. S. P.

PAVILION HOSPITAL PLATE III



FLOOR PLAN

Geo. H. Baker Lith. S.E.

As with a similar table, published in the last report of this Board, the accompanying table compares most favorably in its results with the showing of the best ordered hospitals in the world. Taken in connection with the fact of their crowded condition, and short allowance of cubic space for air to each patient, and necessarily defective ventilation, especially in the instances of the Lunatic Asylum, the hospital wards of the San Francisco Almshouse, and of the State Prison, and most of the County Hospitals and jails, these results afford the most unequivocal evidence of the benefits that have accrued from their skillful medical administration.

It may here, with some reason, be asked, if these facts be so, why is it that so much space has been given in this report to the construction and hygiene of hospitals?

Now, it must be remembered that the hospitals, prisons, etc., mentioned in these statistics, have been constructed of recent date, and, although defective in most hygienic respects, still have not yet become so permeated with organic impurities emanating from the bodies of the sick, as to render them comparable in percentage of mortality to other hospitals; but this state of things may not continue much longer. The safety of patients requires freshly built wards, for it is now beginning to be recognized that hospitals should be destroyed and renewed every ten years.

It seems probable that the chances of recovery from fever or from the results of a surgical operation are, on the whole, greater in a squalid home in any large city, even, than in the largest and best appointed hospital in London or Paris—so dangerous is the concentration of many sick to each individual patient. An influence capable of causing disease, emanating from one or from a few individuals, is usually so dissolved and diluted as to be harmless. From a large ward, however, exhalations perceptible to the smell are generated, which saturate the very walls, and poison successive series of inmates. That noble and learned physician, Sir James Y. Simpson, who first proved the virtue of anæsthetics, by inhaling chloroform himself, among his other priceless benefactions to humanity, taught the true doctrine of hospitalism. By the answers to an extended series of circular letters of inquiry, he established the fact that out of two thousand and eighty-nine cases of amputations performed in great hospitals in cities, eight hundred and fifty-five died, while in country practice, out of two thousand and ninety-eight similar operations, only two hundred and twenty six died. Hence, the number that die after amputations in hospital practice, when compared with rural practice, is nearly four times greater. In the study of hospital hygiene, during the last few years, the fact has been disclosed again and again that the great hospital is as liable to destroy life as to save it. This fact led Florence Nightingale to enunciate as the very first requirement in a hospital, "that it should do the sick no harm."

These remarks respecting the detrimental influences of the agglomeration of a large number under one roof, without adequate ventilation, apply with equal force to our jails, prisons, factories, and machine shops, etc. To show how, in one instance among the many that may be adduced, disease is contracted from long confinement in ill ventilated chambers, I will here cite the results of an effort that has recently been made by Dr. A. L. Leach, of Philadelphia, to procure and ascertain, by means of the vital statistics of the most important prisons in the

United States, the percentage of deaths occurring in these institutions from phthisis. Owing chiefly to the imperfect manner in which the records have been kept, especially in the Southern States, but partial success has been attained—only sufficient to construct the following:

TABLE

Showing the total number of deaths in prisons (those from accident included), the whole number from phthisis, and the percentage. Under the head of phthisis, are included those dying from scrofula.

Prisons.	Period of years.	Total number of deaths.....	Phthisis.....	Per cent.....
Moyamensing Prison	32	282	177	62.76
Maryland Penitentiary	20	187	72	38.50
Vermont Penitentiary	2	6	5	83.33
Sing Sing Prison	20	339	113	33.33
Kentucky Penitentiary	12	116	37	31.89
Connecticut Prison	30	177	107	60.45
New Jersey Prison	10	79	60	75.94
Auburn Prison	51	575	231	40.17
Clinton Prison	1	6	2	33.33
Eastern Penitentiary, Pennsylvania	6	51	30	58.82
Totals	184	1,818	834	45.87
California State Prison	5	53	19	35.85

It would, doubtless, add to the value of these statistics to pursue these investigations further—into machine shops, factories, asylums, almshouses, and other charities—and show the influence of close confinement there met with in the development of phthisis; but we think the fact is sufficiently established that all conditions of life, in which confinement occur, have this influence. Accepting the modern doctrine taught by Virchow, that most diseases have a local origin, the facts already collected possess a language that is mute, but eloquent, and should touch the hearts of the humane. "To-day," in the forcible words of the writer first referred to, "consumption pursues its onward march, numbering its victims by thousands and tens of thousands, and we stand appalled. The brilliant eye and hectic flush of phthisis greet us upon every hand in those hurrying from our factories, our machine shops, sewing rooms, countinghouses, and every station of life, and they should cause us to be busy with attempts at the reformation of so much misery and suffering. In every community societies are formed for the 'prevention of cruelty to animals;' but a society is yet to be formed for the noblest of works—the prevention of cruelty to human beings. All over this broad land—in our prisons, in our factories, our schoolhouses, our workshops, etc.—a cry goes up from human misery pleading for more breathing room, more active enforcement of hygienic laws. Men, convicted it may be of some petty crime, are sentenced by our Courts to a few months imprisonment, but virtually are *sentenced to*

death. They are incarcerated in cells originally intended for one convict, but now crowded with others. A few months suffice, and the convict perishes, or leaves with the germs of phthisis sown, that in future years end his existence. And yet the evil does not end. These convicts may become the parents of offspring, who may reach years of maturity, and while in its full glory are stricken down with phthisis, and thus the sources of so much human misery and woe may continue. We want in this country more prison room, houses of correction for the class of our criminals convicted of minor offenses, and the strict observance of the laws of hygiene. Human beings are packed and crowded together in the public institutions of our cities, in the hovels of the poor, and even among our better classes; shut up through the day, emerging to spend their nights in dissipation, and are yearly dying by thousands, swelling the mortality of consumption. These deaths plead in trumpet tongues, and ask us to be busy with the problem 'How is the evil to be remedied?'"

The Executive Committee of the Prison Association of New York, in their annual report for eighteen hundred and sixty-nine, introduce the subject of the county jails of that State in the following language: "A popular preacher in Brooklyn said recently in a sermon: 'Look at our jails! They are a disgrace to civilization. Some are fit to put wild beasts in, but most of them are not.' The rhetoric is strong here, but there is a terrible basis of truth underlying it. There may be half a dozen jails in the State properly constructed to meet the exigencies of the existing system, but in general they are as faulty in construction and arrangement as they well can be—dark, damp, cramped, ill ventilated, and gloomy in the extreme." This description might also have been written for the jails in California. We have reason to hope, however, that the advancing civilization of the age, and the knowledge to be derived from the attraction of public attention at this time to the general subject of prison management, will not permit this condition to be permanent. Mistaken and ill-judged economy no doubt contributes largely to produce the miserable state of so many of our prisons and jails, and the question of cost will be one of the obstacles to reform. Assuming, however, that public sentiment, once awakened, will insist upon improvement, the necessity for rebuilding or remodeling a great majority of the county jails becomes at once apparent.

The authorities in our metropolis have taken a step in the right direction by the passage of an ordinance punishing every person who does not allot to himself or herself five hundred cubic feet of air in the sleeping apartment. Up to this time, however, all prosecutions for the violation of this law seems to have been directed exclusively to the Chinese. The original intention of awarding five hundred cubic feet of air to each individual in a sleeping apartment was to fix a standard for the construction of hospitals, and the size of the building and its apartments were made to correspond in that proportion to the number of patients admitted. No one ever dreamed that it should be applied as a hygienic rule for every-day life, or adopted as a guide for legislative action. A room ten feet high and seven feet square will give four hundred and ninety cubic feet of air, and is sufficient, under ordinary circumstances, for one person; but if that room be void of ventilation, the atmosphere will become so vitiated in the course of twenty-four hours as to be absolutely poisonous. It is not so much a question of cubic

feet, but one of ventilation, which is really at issue, and it would seem from present appearances as if it were intended that the cubic feet principle was to be applied solely to the Chinese portion of our population. As, however, our city authorities have taken the initiative, it is respectfully suggested that our Legislature would enact a State law requiring, at least, all the State institutions to be regulated by a similar five hundred cubic feet of air statute. That such a law is imperiously required, we will point, as an example, to our State Prison.

While we take pleasure in stating, that under the unremitting and scrupulous attention and energy exercised by Governor Pacheco and the resident surgeon, Dr. Randle, the sanitary condition of the prison has been greatly improved, still there remains an urgent necessity for more breathing room, which can only be attained by pushing forward with alacrity the branch prison now in course of construction at Folsom. As shown by the statistics, furnished by the surgeon to date, the average number of prisoners has increased, since the last biennial report, from nine hundred and twenty to one thousand and fifty, and there is a strong probability of a still further increase, judging from the general character of the immigrants now daily arriving.

It is true, notwithstanding this increase, that the average cubic space to each prisoner has been enlarged by the recent improvements, from one hundred and seventy-seven to one hundred and eighty-four feet; but if this, even now, does not come up to the requisite standard, what may we expect the proportion will be before another year rolls by?

Apart from hygienic considerations, there is a necessity for classifying and grading the prisoners, that those susceptible of moral improvement might be exempted from the contaminating influences of the incorrigibly vicious. This demand can never be met, so long as sixty are allowed to sleep in one room. Some of these may be wholly innocent, others guilty of some slight misdemeanor, and others still, utterly blasted and gangrened by a long course of crime. Is it not supreme injustice to compel a contact of the former with the latter; and is not a State that incarcerates one of her citizens for any cause, bound by every principle of rectitude to use all possible precautions against his being restored to society a worse man than when he was arrested?

Researches into criminal statistics reveal the fact that in the State Prisons of the United States the proportion of minors incarcerated, taking the average in them all, is over twenty per cent; that in one it rises to nearly fifty per cent; and that in several others it exceeds one fourth of the whole number; that the tendency in every department of vice and crime seems to be of late years *youthward;* that thieves, pickpockets, burglars, and indeed every class of criminals average many years younger now than they did a quarter of a century ago, and that the same is true of drunkards. Such being the testimony of the Executive Committee of the Prison Association of New York, an organized and well devised attempt at reformatory discipline, such as our present system does not afford, cannot be begun too soon.

The best example of a reformatory or intermediate prison, is that of the Detroit House of Correction. Its Superintendent, in an able paper, says:

"The design of those institutions is twofold, viz: preventive and reformatory—to restrain and prevent the manifestation of the vicious inclinations of the class described, and to improve the character of the individuals who commit offenses and are imprisoned therefor. The true

interests of society are best promoted by those measures that prevent the perpetration of offenses and the growth of bad character in its members; for every infraction of law not only mars the character of the offender and brings into activity a bad element, but is a shock to the fabric of society, weakening the whole structure in proportion to the trivial or heinous character of the offense. The Christian institutions, benevolent and charitable societies, and educational establishments, are all, in the nature of their organization, admirably adapted to this work; but as their influence does not perfectly accomplish this end, some other provision is necessary for the treatment of those who break through these restraints, and actually enter upon a vicious course, leading, as vicious practices always do, towards the commission of the higher crimes. * * * * The reformatory designs of these establishments must not and need not be lost sight of in our zeal for their preventive influence, for the highest welfare of the inmates is perfectly consonant with the best welfare of society at large. I do not hesitate to say, that in the reformation of prisoners, and in wise efforts to that end, will be found a key to the true prison system, and the soundest criminal code. * * * * * *

"The design of these municipal or intermediate establishments, then, may be stated to be the treatment of persons who commit offenses against society, known as misdemeanors, with the view to exert a preventive and reformatory power—the preventive force being most surely had, and in largest measure, by locating, constructing, organizing, and administering them for the main purpose of reformation. * * * *

"They must be legislated into existence as a part of society, in harmony with every means she adopts for her preservation and the highest development and welfare of her members. Just as hospitals and asylums are instituted to heal physical and mental diseases, so these prisons should be established to cure moral deformity. They are needed as adjuncts to the various refining and purifying agencies, to make further effort in the same direction for those, who are not held by them, to symmetrical, moral development, and who become an offense to society in spite of them."

TABLE

Exhibiting the number of indigent sick, with the results, in charitable institutions, and the percentage of deaths to the cases, during the year eighteen hundred and seventy-four.

Name and Location of each Hospital.	No. of months reported	Total admitted.	Discharged cured	Discharged	Died	Percentage of deaths	Remaining under treatment.	Physicians.
Sacramento County Hospital, Sacramento	12	682	515	.....	55	8.0	112	G. A. White, M. D.
Central Pacific Railroad Hospital, Sacramento	12	1,055	995	20	11	1.0	29	A. B. Nixon, M. D.
Colusa County Hospital, Colusa	12	93	64	10	5	5.3	15	J. M. Banks, M. D.
San Bernardino County Hospital, San Bernardino	12	26	10	.....	7	27.0	9	J. C. Peacock, M. D.
Fresno County Hospital, Millerton	12	35	19	4	3	8.5	9	Lewis Leach, M. D.
Los Angeles County Hospital, Los Angeles	3	85	32	5	10	11.7	38	H. S. Orme, M. D.
Sierra County Hospital, Downieville	12	37	16	6	8	21.6	7	Alemby Jump, M. D.
Napa County Hospital, Napa City	12	83	59	4	5	6.0	15	M. B. Pond, M. D.
Solano County Hospital, Suisun	12	90	56	7	7	7.7	20	Jas. F. Pressley, M. D.
State Prison Hospital, San Quentin	12	91	64	.....	7	7.7	20	T. W. Randle, M. D.
Shasta County Hospital, Shasta	9	38	19	.....	5	13.1	14	J. E. Pelham, M. D.
San Francisco City and County Hospital	12	3,547	1,968	967	275	7.7	337	W. M. Lawlor, M. D.
Calaveras County Hospital, San Andreas	12	75	19	24	8	10.6	24	E. B. Robertson, M. D.
San Mateo County Hospital, Redwood City (1874-5)	12	55	39	10	2	3.6	4	C. A. Kirkpatrick, M. D.
Mariposa County Hospital, Mariposa	12	29	9	7	5	17.2	8	O. F. Shaw, M. D.
San Diego County Hospital, San Diego	12	73	36	14	15	20.5	8	C. M. Fenn, M. D.
State Insane Asylum, Stockton	12	1,733	238	74	179	10.3	1,242	G. A. Shurtleff, M. D.
Sacramento County Dispensary, Sacramento	12	1,080	990	27	10	0.9	53	C. H. Fisher, M. D.
State Woman's Hospital, San Francisco	24	352	113	219	4	1.1	16	John Scott, M. D.
Alameda County Infirmary, Alameda	12	191	97	.....	22	11.5	72	C. S. Coleman, M. D.

*Almshouse, San Francisco, (1874-5)	12	314	.....	19	47	14.9	248	.....S. R. Gerry, M. D.
Santa Cruz County Hospital, Santa Cruz	6	41	25	2	1	2.4	13	.....C. H. Anderson, M. D.
Del Norte County Hospital, Crescent City	12	4	1	1	1	25.0	1	.....O. B. Adams, M. D.
Modoc County Hospital, Adin	5	2	1	.....	.....	0.0	1	.....H. F. Hall, M. D.
Kern County Hospital, Bakersfield	12	20	6	9	1	5.0	4	.....H. S. Backman, M. D.
Siskiyou County Hospital, Yreka	12	27	19	4	1	3.7	3	.....D. Ream, M. D.
Sonoma County Hospital, Santa Rosa	12	149	96	21	12	8.0	20	.....J. B. Gordon, M. D.
Tulare County Hospital, Visalia	6	74	51	6	12	16.2	5	.....M. Baker, M. D.
Santa Clara County Hospital, San José	12	332	225	.....	35	10.5	52	.....A. J. Cory, M. D.
Home for Inebriates, San Francisco	24	815	780	14	13	1.6	8	.....A. P. Hayne, M. D.
†St. Mary's Hospital, San Francisco (1874-5)	12	979	498	312	83	8.4	86	.....C. G. Kenyon, M. D.
‡City Prison, San Francisco (1874-5)	12	625	.....	.....	14	2.2	.....	.....Chas. Black, M. D.
County Jail, San Francisco (1874-5)	12	971	.....	.....	1	.....	.....	.....Chas. Black, M. D.

* In former reports, the statistics of only those under treatment in the hospital, were given, consequently the percentage of deaths was much greater. A large proportion of the inmates are either hopelessly or partially invalided; and instead of the institution being an almshouse, it might with more propriety be styled an Hospital of Incurables.

† This is a Catholic institution under the charge of the "Sisters;" and the report is made up of the cases occurring in the charge of the visiting physicians, Drs. James Murphy, James P. Whitney, and Geo. H. Powers.

‡ The City Prison Hospital is used as a receiving hospital for all cases of accident occurring in the City of San Francisco. It consists of two suitable rooms, in the basement of the City Hall, containing four beds. Patients are admitted, dressed, and prescribed for, and next day, if necessary, transferred to the City and County Hospital, or sent to their respective places of residence.

In the San Francisco County Jail but one death occurred during the twelve months, as shown in the table, and that was in consequence of congestive chill.

SAN FRANCISCO LYING-IN AND FOUNDLING HOSPITAL.

THOMAS M. LOGAN, M. D.,
Secretary State Board of Health:

DEAR SIR: I am preparing the manuscript for a printed report embracing the period you ask for, and had expected to send you long ere this a copy of it, but one cause of delay after another has prevented its completion; therefore, I send you an abstract from it now.

There have been delivered in the hospital eighty-two patients, of eighty-two children—forty-three males and thirty-nine females; the mothers ranging in age from fourteen years old and upwards. Nearly all were primiparas; their average stay in the hospital not less than heretofore—about four months. In religion, two were Hebrews; thirty-eight Protestants, and forty-two Roman Catholics. Their nativities are: Californians, twenty-one; from other States and Territories, thirty; from foreign countries, thirty-one. The Californians were: from San Francisco, six; Sacramento, two; Yuba County, two; Santa Clara County, two; San Joaquin County, two; Nevada County, one; Solano County, one; Alameda County, one; El Dorado County, one; Contra Costa County, one; Santa Cruz County, one; Monterey County, one—total, twenty-one. Those from foreign countries are: Ireland, eleven; Canada, four; Nova Scotia, two; France, two; Italy, two; Switzerland, one; Africa (born of white parents), one; Mexico, one—total, thirty-one. Not a death occurred among this whole number.

I wish we could say the same of the foundlings, numbering one hundred and eighty-seven, which we have had to provide for. Eighty-two of them were born in the hospital, and one hundred and five were left at the door of the asylum, by parties unknown; making one hundred and eighty-seven. Of these, I have procured the adoption of seventy-four; nineteen were taken by mothers or their friends, and five remain on hand; making ninety-eight saved; leaving eighty-nine to be accounted for. Of these, one was left a corpse in the receptacle at the door of the asylum, with this memorandum: "Please bury my child, for I am too poor to do so." Of five prematures, three were stillborn; one weighed one pound, and died in one hour; and one in four hours; eight died under three days old; the remainder (seventy-five) died from a week upwards; making a larger per cent saved than at any previous report.

Since the former report we have rented the premises then alluded to, and now have two frontages, of thirty feet each, viz: at 762 Mission street and 269 Jessie street, by a depth of one hundred and sixty feet, opened up into one lot, affording a sheltered spot in the open air for the hospital patients and the children of the asylum. The whole is thoroughly drained, by sewers emptying into the Mission street sewer. The premises 269 Jessie street are now wholly occupied for the Lying-in Hospital, affording additional rooms for patients, but we have not had the means to furnish all of them. The rooms, numbering twenty, contain, in the aggregate, upwards of thirty thousand cubic feet of air, and are thoroughly ventilated. The Mission street building, containing eleven rooms, is occupied for the Foundling Asylum, and contains, in

the aggregate, about the same number of cubic feet as the hospital, and is as well ventilated. This building rests upon a lot from which a sand-hill was removed. The front rooms have a southern exposure; consequently our infants occupy sunny rooms throughout the day, obviating the charge made against the rooms they occupied in the Jessie street premises. I can now confidently assert, that so far as sunny and well ventilated rooms are considered in connection with the health of the children, that they are all that can be desired for the largest number hitherto occupying them. These numbers have varied weekly, ranging from five to twenty on hand at a time.

As our institution is so peculiar in its organization, differing from all other special or general hospitals in the State, I have been unable to adapt it to the printed formula you sent me. I therefore hope that the foregoing abstracts will give you the desired information.

Yours, most respectfully,

BENJAMIN F. HARDY, M. D.,

Attending Physician and Surgeon of the San Francisco Lying-in Hospital and Foundling Asylum.

[Office, 762, residence, 824 Mission street, San Francisco.]

THE INSANE, AND WHY SO MANY.

By G. A. SHURTLEFF, M. D., Superintendent Insane Asylum at Stockton.

Owing to the increase in the population of the State, and the unusually large immigration, the admissions into the Insane Asylum at Stockton during the past year have been greater than during any previous year in its history. Six hundred and sixteen patients were received during the year. The increase, however, though greater than the average, is not so great as it has been in several former years. There has been an increase of seventy-nine patients during the year. The discharges, exclusive of elopements and deaths, amount to fifty-three per cent of the number admitted, and the recoveries to forty-two per cent. The death-rate has been lower than it has been for seven years past, it being 9.83 per cent on the whole number under care.

The following summaries exhibit the number of patients in the State Insane Asylum at Stockton, California; the number of admissions, discharges, deaths, and elopements for the years ending June thirtieth, eighteen hundred and seventy-four and June thirtieth, eighteen hundred and seventy-five:

	Males.	Females.	Totals.
Number of patients July 1st, 1873	832	324	1,156
Number admitted during the year	386	138	524
Number under care and treatment	1,218	462	1,680
Number discharged, recovered	158	51	209
Number discharged, improved	29	11	40
Number discharged, unimproved	3	3	6
Number died	136	42	178
Number eloped	23	.....	23
Discharged, died, and eloped	349	107	456
Number of patients July 1st, 1874	869	355	1,224
Number admitted during the year	447	168	615
Number under care and treatment	1,316	523	1,839
Number discharged, recovered	192	66	258
Number discharged, improved	33	30	63
Number discharged, unimproved	5	3	8
Number died	136	45	181
Number eloped	26	.....	26
Discharged, died, and eloped	392	144	536
Number of patients July 1st, 1875	924	379	1,303

The institution is crowded inhumanly. More than six hundred patients have been received since relief on the plan adopted for its early realization by the projectors of a new asylum, was to have been had. On this account the patients have suffered inexpressibly for room, as the whole body of officers and employés have in extra work, embarrassment, and anxiety. Fortunately there has been no endemic or general sickness; but on the contrary, remarkable healthfulness has prevailed. Such a violation of an established law of hygiene with impunity, can only be accounted for in the advantages of a climate so mild and equable that the outdoor air may be allowed to sweep freely through the apartments at all seasons, night and day, without discomfort or injury.

The prevalence of insanity in California has led many to suppose that our climate has some direct influence in its production. There is no foundation, in fact, for such a belief. It is true that upon those parts of the earth's surface most favorable to the development of man's energies, to intellectual activity and advancement, insanity will be found in the largest proportion. This is not from the direct effect of climate, but on account of the more artificial and complex mode of life, and the greater strain to which the mind is subjected in an enterprising and progressive population. Our climate, from its agreeable temperature, and healthful and invigorating influence, is conducive to a full share of that mental activity and effort found in the world's great belt of intellectual development and progress.

It is the struggle for equality or supremacy in all the innumerable pursuits of civilized life, which puts the mind to a test in which the defective are likely to fail. Before the period of active progress in California which followed the gold discovery of eighteen hundred and forty-eight, insanity was unknown, though the missionary settlements had then existed more than three quarters of a century, and though there was, prior to the gold-seeking immigration, a population estimated at fifteen thousand, of European extraction. At the present day the same number of people, according to the ratio of insanity to the general population, would furnish the insane asylum with thirty patients. In eighteen hundred and fifty-two, when all the insane of the State were placed in the hospital at Stockton, out of the one hundred and twenty-four sent there during that year, only three were natives of California. During the seventy-five years already referred to of the partial settlement of this country by the Spanish-Americans, and other white races, not only was no insanity developed by the climate, but no predisposition to it seems to have been established. After the exciting causes had been in most active operation for four years, and had completely changed the habits, chief pursuits, and the government of this pastoral people, there was only one insane person to five thousand of the native class, while of the recent immigration there was, at the same date, already one insane person to two thousand of population of the same class.

The shock of transplantation, separation from family and friends, disappointments, disastrous enterprises, sudden reverses of fortune, intemperance, fast living, and an unsettled condition of life, are the chief causes of mental disorder on the Pacific Coast. These causes, or most of them, are much more rife in a rapidly increasing population, receiving large accessions annually from the influx of a very distant emigration, than in a more stationary community, whose growth is natural, and proceeds mainly from the multiplication of its own offspring.

It is a serious undertaking for a family, uncertain of sufficient means and anxious of the result, to break up an old home, with all its local attachments and endeared associations, and remove three thousand miles away—so far that distance bars return. Add to the effect of this the probable disappointment and dissatisfaction in establishing a new one, and we have produced on the mind what I have termed the shock of transplantation. Hence there has always been in the foreign immigration of all the States, a large ratio of insanity. In California we have not only a large population of foreign birth undergoing these changes and trials, but our domestic immigration, coming from remote parts and various climes, suffers similar trials and results.

But in addition to these causes of insanity in California, there are peculiar circumstances of location, which give her a great number of insane annually who do not legitimately belong to her. Once committed to the asylum, however, they are counted as her own; and, owing to the remoteness of the places to which they properly belong, they become fixed here for life unless they recover.

Central California, or more exactly our metropolitan city, is situated at the great western gate of the world's travel and commerce, where people, from east and west, converge and rest on their long journeys. This passing throng, the countless numbers floating on the Pacific Ocean, under every flag, from Arctic to Antarctic, and the sojourners upon her remotest islands, all produce their quota of insanity, much of which finds its most available refuge in our State Insane Asylum. Produced by such abundant exciting causes within its own limits, and a place of refuge for so many from without, the great number of insane in California is an inevitable consequence of its mode of settlement, the habits and condition of its inhabitants, and its peculiar situation—isolated and remote, yet in the thoroughfare of travel and commerce.

Again, we have in our State a great many unfortunate persons classed and enumerated as insane, who, in many other States and countries, would not be counted as such. There is no general provision made, by either the State or the counties, for those who are simply incapable of taking care of themselves, or are harmless in disposition and intent, and are yet irresponsible from sheer lack of mind, or from mental weakness. The maintenance and care of the insane, at the State Insane Asylum, is not a municipal or county charge, to be paid by the city or county from which the patient is sent. The consequence is, that nearly every form of mental infirmity and impairment, in persons who are indigent and become burdensome, is called insanity, and the subjects thereof are committed to the Insane Asylum. Hence we have counted as insane mere simpletons, epileptics who are simply troublesome, senile dements, methomaniacs, and so forth. Take from the insane these classes, who in Europe and the older States would be provided for in more appropriate and other public institutions than hospitals for the insane, and the sum total of insanity now ascribed to California would be materially reduced.

There is nothing which presents insanity in such startling proportions as a full enumeration of all its subjects, and an effort to provide for them all at public expense. Twenty years ago, when Massachusetts undertook this proceeding, faithfully accomplishing the first part of it but failing in the latter, there were found within her borders one insane person to every four hundred and fifteen of the general population, and many more unprovided for than were maintained, or could be accommodated, in her institutions established specially for their care.

"In the short period of nineteen years the estimated proportion of the insane in England rose from one in seven thousand three hundred to one in seven hundred and sixty-nine"—a difference of more than nine hundred per cent—produced, not by an increase in the ratio of insanity, but by a better knowledge of the extent of its existence. Dr. Bucknell estimates that in England and Wales there is one insane or idiotic person to every three hundred of the population.

The insane of our State are presented in an unprecedentedly conspicuous light, from their number being known, from the custom of publishing their commitments to the asylum, and from provision being made for the care of all of them by the State.

The insane of the State, including idiotics (of whom there are but few), and every species of mental unsoundness, number about fourteen hundred, and the population of the State is estimated at seven hundred thousand. This gives one insane person to every five hundred of the general population. We may calculate on this ratio for an indefinite period to come. Thus it is seen that an increase of one hundred thousand to our general population will be accompanied with an addition of two hundred to our insane population.

Of the fourteen hundred insane persons, or persons of unsound mind, in the State, upwards of thirteen hundred are in the Insane Asylum at Stockton. The balance is made up of such mild cases of mental impairment or defect as are taken care of at home by their friends, from choice, or do not require isolation.

NEW STATE INSANE ASYLUM, AT NAPA.

OFFICE OF CALIFORNIA STATE BOARD OF HEALTH,
SACRAMENTO (Cal.), July 30th, 1875.

ED. BENTLEY, M. D.,
Superintendent Napa State Insane Asylum:

DEAR SIR: I am informed, through a communication received for publication in the Biennial Report of the State Board of Health, from Dr. Shurtleff, Superintendent, that the State Insane Asylum at Stockton is inhumanly crowded. "On this account the patients have suffered inexpressibly for room, as the whole body of officers and employés have in extra work, embarrassment, and anxiety."

Will you be kind enough to report at your earliest convenience, so that our legislators may act advisedly, as to the progress of the building of the new asylum at Napa, and how soon, in your opinion, it can be made available for the relief of the asylum at Stockton.

Also, it is desirable to know whether the Directors of the Napa Asylum have secured the water privilege, conformably with a bond that was to have been entered into with Nathan Coombs, proprietor.

In my report to Governor Booth, in eighteen hundred and seventy-two, when deciding on the site of the Napa Asylum, I urged the necessity of purchasing more land, and especially that portion of the tract encompassing the mountain brook from which the water supply is to be obtained. Has the suggestion been acted upon; and if so, what is the result?

An early response, as my report is now ready for the State Printer, is respectfully solicited.

Yours, truly,

THOS. M. LOGAN,
Secretary State Board of Health.

SAN FRANCISCO, August 6th, 1875.

Professor THOMAS M. LOGAN, M. D.,
Secretary State Board of Health, Sacramento:

MY DEAR SIR: In reply to your inquiries of the thirtieth ultimo, asking when the State Insane Asylum at Napa will be able to relieve the Stockton Asylum, I have the honor to state that, in my opinion, every possible effort is being made to further the best interests of the State, in prosecuting the work on the asylum, and that the Directors have been actuated in the highest degree by the humane desire of relieving Stockton at the earliest moment; and I am happy to be able to announce

to you that the north wing is so far advanced in the process of completion that we may reasonably expect to receive patients in the latter part of the present month, and to this end every effort is now being made. I may add that the entire structure is progressing as rapidly as can be deemed consistent or desirable, when the permanency and enduring character of the work on this extensive edifice is taken into consideration.

In regard to the water supply, the contractors have availed themselves of it in various ways to great advantage in the different departments of construction, and the Directors have taken an active interest in securing and maintaining all privileges pertaining to it. I have no doubt the present supply will be ample for the working of the asylum, with a large reserve always on hand for any emergency in the reservoirs in the towers; but additional improvements are contemplated, and will be needed before its use can be appropriated to any extent for purposes of irrigation. So far as relates to the bond "that was to have been entered into with Nathan Coombs, proprietor," I am not definitely informed.

In your report to Governor Booth in eighteen hundred and seventy-two, you very properly and wisely urged the necessity of purchasing more land, and especially that portion of the tract encompassing the mountain brook. This suggestion, I regret to say, was not carried out, and the subject now, as then, commends itself to the early and earnest attention of all concerned in the best interests of the asylum.

Very respectfully,

EDWIN BENTLEY,
Medical Superintendent Napa State Insane Asylum.

SECOND REPORT ON PROBATIONARY ASYLUMS FOR THE INSANE IN LARGE CITIES.

By A. B. STOUT, M. D., San Francisco.

In accordance with the first report on this subject, submitted to the honorable Legislature of California, a bill, under the auspices of the State Board of Health, was presented for the adoption of this reform in State medicine, to that body, at its last session.

Owing to the heavy appropriations made by the State so recently, to construct an Insane Asylum at Napa, and also the very nervous state of mind of the Legislature in regard to public economy, reduction of appropriations, and increase of taxation, the bill was unfavorably reported upon by the committee it was referred to, and consequently failed to pass. The action of the committee in nowise diminished the merit of the proposition.

Constant observation and experience since the incipiency of this project of hygienic reform, have greatly contributed to increase the testimony of its expediency, its utility, and its necessity in the cause of justice and humanity.

In this view we shall renew our efforts, and present this second report, as supplementary to the first, in order to reinforce the latter with additional evidence and further argument.

A Probationary Asylum for the Insane does not imply solely an institution within which to determine and detect feigned insanity, or falsely charged insanity, and thus intercept the frauds and injuries attempted in litigation, whether in civil or criminal prosecutions. Great as would be the advantage of possessing such a check, guarded by commissioned experts in lunacy, and with legal power to inforce seclusion without sacrifice of the constitutional rights of man, it is not in this alone that the proposed establishment possesses merit.

In an extended meaning the word *probationary* signifies *tentative*, or an institution in which the effort is made to afford relief by quick and prompt intervention in the incipiency of mental disorders, and thereby prevent the disasters which so often render simple physical disorders, accompanied with mental alienations, forever incurable; and then entail the long catalogue of family calamities and the revolutions in matters of estate. We say, with confidence, that the large majority of such cases, as they now stand recorded, is the result of *neglect* not necessarily willful, but from the want of the required facilities in the incipiency of the invasion of the malady to arrest its progress. Give it no foothold, it will fail to hold possession. As things now are, parties interested, in the most loyal faith, rush around for relief, but can only find it after protracted and expensive delay. It is just in this delay that the irreparable damage is done. How perfectly would this evil be averted, could they *quickly* transport the person without delay to the provident asylum of the State. In extreme perils, it is admitted that humanity and self-defense take precedence of law and the individual right of liberty.

This last mentioned right we would be among the last to infringe, but this right has its limit. An insane man on the street menacing great harm to himself or others, would be arrested instanter, and be confined in prison, at least for a short time; but insanity being neither a crime nor a willful misdemeanor, he has only deserved confinement; not, however, in a prison, but in a hygienic place of restraint authorized by legal enactment.

No one would suppose, in the case cited, that a suit for false imprisonment would be entertained, yet suits of this character have been brought by persons confined against their protest, although insane, in private asylums, so that such institutions have become, often harmfully, guarded against whom they receive. What, now, becomes of the person thus "arrested instanter?" He is punished, virtually, though only the subject of an involuntary disease, or with hereditary reference, he is imprisoned for his father's misdemeanors. This is not all, he may pass a night in a comfortless cell, perhaps the subject of felons' curiosity or diversion; and yet the exposure, want of care, of food, of sleep, that night, might fix uncurability upon his case, which would have been cured in a few days, had he been transported "instanter" to a humane asylum, provided immediately with a comfortable bed, seclusion, but among kind friends, without disgrace, and the required food, the needed sedative, and, in last recourse, the harmless "*camisade de force.*" Yet, more, the helpless maniac is made a subject of notoriety; his name is reported in newspapers, with all the story done up, perhaps, in ridicule, to please morbid tastes; hence, for weeks, he is subject to annoyance; his family and business relations damaged, and, finally, a bill of useless expenditures; or if some mistake occur, or friends fail to appear, thirty days in the County Jail.

Now all this scene would be evaded by the alternative proposed, while the unfortunate invalid would be humanely and silently cared for without undue notoriety.

We offer this to show the importance of instant relief in cases of sudden outbreaks of insanity.

Part II.

Relief in the first stages of insanity.

There is nothing incompatible in a Probationary Asylum, as explained already, in the last biennial report, with the addition of a department for the cure of alcoholism in its first invasions, and while yet a curable disease. A Home for the Inebriate could, therefore, be annexed to the institution. There are about ten such homes in the United States, one of which, to our honor be it said, is in San Francisco. This latter is, however, a private charity, sustained by a few humanitarian individuals. The question of the intrinsic value of benevolent aid-resorts for the ills of intemperance has been largely discussed. Socialists and philanthropists have not failed, whether or not they are truly wise provisions against those "ills that flesh is heir to." It would be vain to recapitulate them here; but the result of the investigation is, that on grounds of sound social economy, as well as accordance with the dictates of Christian conscience and the general indulgence of popular sentiment, that they are not only wise and good, but indispensable. With or without comment as to how they come, delirium tremens and alcoholism are diseases,

the subjects to which have their natural claims, as members of the body politic, like those diseased from all the other objectionable irregularities of social life. A very large proportion of such cases, if early relieved, are perfectly redeemable, which now are lost by maltreatment at the outset.

Now, it is well known to medical men, if not to legislators, that inanition from want of food, and exhaustion from insomnia or want of sleep, are the symptoms most destructive and the most difficult to combat. Abundant food and rest are, therefore, the indispensable requisites. As things now go, do inebriates get this treatment? As for themselves, they repugn food, and are driven by an uncontrollable brain to inordinate physical efforts and insane mental activity. They resist what they most need. In many cases food and rest can only be procured by a force applied with method. Generally, in the cases brought for hospital treatment from the streets, from jails, from their homes, many days, often weeks, have been consumed in the various tentatives of friends or others to obtain relief, while in this very time the precious moments to administer aid escape and have flown forever.

It must be manifest that to control these exigencies in the incipiency of alcoholic insanity, the opportune moment, time, skill, and place, can only be found combined in such an institution. What has been already well said need not be rewritten; we, therefore, adopt and append to this report the three following essays on the subject. (See Documents A, B, and C.) Such valuable and disinterested testimony should be decisive evidence. It would be vain to continue further the discussion at present, as the report would become unreadable by reason of its length; hence, we commend it to your approbation.

A. B. STOUT, M. D.,
Member State Board of Health.

[*DOCUMENT A.*]

WHAT SHALL BE DONE WITH THE HABITUAL DRUNKARD?

By JAMES F. HIBBERD, M. D.

[A paper read to the Wayne County Medical Society, January 7th, 1875, in support of the resolutions attached.]

It is not the intent of this paper to discuss the general subject of intemperance, but to consider that phase of it which is denominated habitual drunkenness. And by this phrase is meant that condition of a man wherein he drinks alcoholic beverages to intoxication whenever opportunity offers. Not when opportunity incidently offers merely, but who makes opportunity when none offers otherwise. In other words, a man is an habitual drunkard when the desire for alcoholic beverages becomes his ruling passion, and the drinking of them his leading practice, and all for the sake of the intoxication they produce.

When a man has arrived at this stage of a drunkard's career, he has lost the higher characteristics of his manhood. He has lost his recognition of the dignity of his position in the scale of created beings; he has smothered his moral nature; he has drowned his sense of honor; he has dishonored the ties of consanguinity; and he has ignored his obligation to care for himself and for those dependent on the proper exercise of his physical and mental ability.

This condition is never, it is believed, a congenital one, but always the result of education or training—a condition into which the victim voluntarily enters; yet, nevertheless, one, when fairly entered, he can no more control than he can control the advent of hunger, or the necessity for sleep.

In short, under the change wrought in his mental operations through alterations induced in his physical organization by the action of alcohol, he has become irresponsible for his acts. Disease has been engendered in his body, such that it makes the healthy action of his mind impossible. And this abnormal mental activity is a species of insanity, differing widely from ordinary insanity in its cause and manifestation, but insanity nevertheless. Perhaps it would be better to regard the term insanity as generic, as it really is, and make the aberration under consideration a species, to be designated alcoholic insanity.

It can scarcely be necessary to enter into a lengthened argument to establish the fact that an habitual drunkard is insane. A very brief argument will suffice.

An insane person is defined to be one of unsound mind. A sound mind being the standard, it becomes necessary to define it, which, for our purpose, may be done by saying that a sound mind, as regards any given department of sociology, is one that approximates the average condition of the minds of all the people in a community touching the duty of an individual in that particular department.

Let us apply this principle. In this community it is the sense of a vast majority of the people that it is a man's duty to provide shelter, food, and raiment for himself and family; to contract no unreasonable obligations, and to fulfill all obligations that he enters into; to protect his own property and to respect that of others; to maintain certain social relations with his neighbors, and to live up to his religious convictions.

Now let us adduce the career of an habitual drunkard, and witness how widely he fails of fulfilling these reasonable responsibilities. There is a married man in this city, an accomplished mechanic, who always had a thrifty establishment until he became an excessive drinker of alcoholic beverages. Then his business ran down, soon utterly faded away, and he became a financial wreck. His family are in rags and insufficiently fed. He works by fits and starts for another man until he obtains some money, then gets drunk, generally has a fight or two, is arrested and fined, induces some one to go his bail, works again until he earns more money, then starts on a fresh spree. Does this man live up to his responsibilities? If not, he is insane.

Another married man allows his wife to do washing to support him and their children, and the little he earns he spends for drink, and occasionally begs, steals, or forces from her, a little of his wife's hard earnings to buy liquor with. Is he fulfilling his reasonable responsibilities according to the standard? If not, he is insane.

An unmarried man, formerly a good mechanic, with full work and plenty of money, is now supported by his brother. He is so devoted to gratifying his love for drink, and so lost to his once high sense of honor and honesty, that if his brother gives him money to buy a pound of butter for the family, he will buy whisky with the money, and return drunk without the butter. Is this man's conduct up to the average of the community in which he lives? If not, he is insane.

Another unmarried man, twenty-five years old, with many accomplishments of manners and mind, lives on his father's bounty, and his sprees are so frequent, and in them he is so violent, that the whole family are in a state of perpetual terror, and are, by his bad conduct, wholly unfitted for the high social duties that their wealth and education would otherwise so admirably fit them for. The father has spent thousands of dollars to repair damages done to property, person, and character by this erring son in his drunken rage. Is this son up to our standard? If not, he is insane.

But is it needful to recite more examples? If the premises laid down be correct, does not every sound mind know of many, alas! too many unsound ones of this particular class. Where is the blood in human vessels that does not have kindred blood coursing through crazy brains—brains that would honor their possessor and his kind, if it were not for the undue ascendency of the fiery king that beguiles and destroys?

We therefore conclude that every man who drinks an excess of alcohol loses his normality, and the most notable feature of this loss is the unsound condition of his mental faculties, and this unsoundness is of the nature of a special phase of insanity.

The resolutions propose to confine a man who is thus insane. Do you ask what right has any man or any number of men to rob a fellow citizen of his liberty? That is the point. We will address ourselves to its consideration for a few moments. Only two adequate reasons can be assigned for such an act; first, to benefit the subject of the restraint, and, second, to protect the community.

But let us for the nonce lay aside the consideration of alcoholic insanity, and in a few sentences review the general relations of society to persons who are esteemed so abnormal as to make it proper, in behalf of the common weal, to deprive them of their liberty, and then apply the deductions that result from the review to the case in hand.

Self-preservation is a great law of nature, and it is just as imperative in a community as in an individual. When any member of a community becomes a source of danger to the common or individual welfare, it is not only the privilege, but it is the bounden duty of such community, through regulations established for that purpose, to interfere and restrain the man. If the danger that attaches to him be from criminal intent, he should be restrained and punished, and reformed, if possible. If the danger arise from disease of a contagious character, he should be restrained and isolated, and restored to health, if possible. If the danger grow out of maniacal fury, he should be confined and treated in an institution specially organized for the management of that form of disease. Suppose it be granted that a man is insane, that is not of itself sufficient to warrant the public authorities to take charge of him so long as he is harmless toward the person and property of others, and has friends who care for him. True, every recently crazy man is considered a fit subject for restorative treatment, and the State at large has provided the place and means for such treatment, of which the friends of the insane may avail themselves, if they choose. But the authorities will not originate measures for arrest and confinement of the insane, unless he be dangerous in some way. This is not a new doctrine. In fact, it is a part of the provisions of existing organizations in every civilized community. Do we not see how constantly criminals are convicted and punished, and that they are sometimes reformed? Do we not see how quickly the authorities will take charge of a man who has the smallpox, or the cholera, and this solely to protect the public against the infection of a contagious disease? And do we not frequently witness the legal inquiry into a man's alleged insanity, and if the inquisition declare him insane, see him sent off to the hospital for treatment? Sometimes these proceedings on behalf of the insane are set on foot in the hope of a cure solely. Sometimes they are inaugurated for the purpose of putting one under restraint whose insanity is of a character to make him dangerous to the persons about him, or to their property.

By operation of the law, as it now stands, if a man commit crime he is punished; if he be dangerously insane he is sent to the hospital for treatment. But if a man be sane, when not under the influence of alcohol, on all subjects except that of drinking, he is not, by the law, held to be insane, albeit he has no power to refrain from drinking, and when drunk is a raving maniac. What is wanted now is a law that will recognize habitual drunkenness as a disease—a species of insanity, in fact, that both the subject's best interest and the general welfare requires should be adequately treated. But as it cannot be properly treated in private houses, the law should, therefore, also provide public institutions for the relief of these otherwise hopelessly ruined citizens, and while restoring the victim of disease to health, would, at the same time, save the public from the consequences of his insane depravity.

A law, however, which is not sustained by public opinion, cannot be maintained in activity for any considerable time; and public opinion will not sustain any enactment that is not in accord with the general sense of right and justice; and the general sense of right and justice will not, and ought not, to sanction the depriving any man of his

liberty, until it be clear that such restraint is the best, if not the only means of preventing great private and public wrong.

It is my opinion that the public head and heart are ready to see that habitual drunkenness is a species of insanity that can be successfully managed only in institutions specially organized for, and adapted to, the end in view. But this function of the public head and heart lies dormant in a great measure, and to make it available for the good end, it must be aroused into active, aggressive life. And to me it seems quite clear that physicians are the leaven that must start the fermentation in the whole mass of the public, which, when fairly leavened throughout, will see as with one eye, and move as if touched by a common inspiration, to establish and maintain the truth, as herein indicated, in an efficient and active manner. Therefore, I ask a vote of approval by this society of physicians, to-day, of the sentiment expressed in the resolutions before it, that we may here and now put this ball in motion, with, on my part, a full hope and an abiding faith that it will roll on until the ideas herein presented shall prevail over the land, and the measures herein indicated shall be put into active operation, and prove the blessed means of curing thousands of men of alcoholic insanity, and saving still more thousands from becoming insane. For, in my judgment, this, or a related plan, which shall hold men to an individual responsibility, offers the only possible means of checking the widespread tendency to the excessive use of alcoholic beverages.

The love of personal freedom, and of the widest liberty of action, is so strong in the American citizen that it will be only an occasional one who will pursue a course of indulgence in an appetite that he knows will inevitably lead him into an insanity for the cure of which he will be incarcerated, and compelled to labor without the liberty to determine the time or character of his work. Perhaps for the people in other countries, the plan under consideration might be futile; but for the people in America, if I do not misread them, you can touch but few chords more sensitive than the desire to drink as often and as much as they please, and one of these is the love of personal liberty and independence.

An affirmative vote on the resolutions, of course, is intended only to have the force of the expressed sentiments of the society on the principle involved. When public sentiment is ripe for the inauguration of institutions to put these principles into active operation, it will not be difficult to draw up plans and specifications that will convince all reasonable people of their practicability, and that the maintenance of them will be no expense to the public at large; that they will sustain themselves, and have a large surplus for the benefit of whoever may be rightfully entitled to the product of the talent and labor of the subjects of this restorative discipline.

RESOLUTIONS.

Resolved, By the Wayne County (Indiana) Medical Society: 1. That it is the sense of this society that persons who drink alcoholic beverages to intoxication constantly, or frequently, and while intoxicated waste the means of living for themselves or others, or abuse themselves or others, should be held to be of unsound mind.

2. That a suitable name for this aberration of mind is "Alcoholic Insanity."

3. That alcoholic insanity being a special form of disordered intel-

lect, arising out of a specific cause, should be treated in institutions specially prepared for, and strictly confined to, this one class of patients.

4. That institutions for this purpose should have three leading characteristics, to wit: first, restraint; second, proper regimen; third, profitable industry.

These resolutions were unanimously adopted and ordered to be published.

[*DOCUMENT B.*]

DELIRIUM TREMENS.

By DANIEL H. KITCHEN, M. D., Chief of Staff, Charity, Fever, and Smallpox Hospitals, etc., New York.

The mental and physical derangements arising from the use, or rather abuse, of alcoholic liquors, are so numerous and variable in their forms and phases, as to cause considerable confusion even among the most eminent psychological and medical experts. The forms most definitely known and understood on this and the European continents, are called alcoholism and delirium tremens, which are separate diseases, and present invariably distinct symptoms; variation, whenever it does occur, being within certain well known limits, precluding the possibility of mistake.

It is an error with some writers to describe delirium tremens as a mania of or arising from intoxication, thereby confounding it with what is recognized as alcoholism. Dr. Ray remarks that "it may be the immediate effect of an excess, or a series of excesses, in those who are not habitually intemperate, as well as those who are; but it most commonly occurs to habitual drinkers after a few days total abstinence from spirituous liquors. It is also very liable to occur to this latter class when laboring under other diseases, or suffering from severe external injuries that give rise to any degree of constitutional disturbance." As regards general temporary incapacity, delirium tremens exercises just the same influence in the total destruction of moral and intellectual responsibility as delirium or insanity from other causes.

Wharton and Stillé, in their Medical Jurisprudence, say that "delirium tremens is not the intended result of drink in the same way that drunkenness is." It is the result of prior vicious indulgences, but differs from intoxication in being shunned rather than courted by the patient, and of being incapable of voluntary assumption for the purpose of covering guilt. That the person under the influence of delirium tremens is mentally, morally, and legally irresponsible for acts done during the paroxysm, is now universally conceded, both within and without the pale of civil and criminal tribunals.

In the case of United States v. Clarke, the earliest case of the kind on record, the Court charged the jury that if they "should be satisfied by the evidence that the prisoner, at the time of committing the act charged in the indictment, was in such a state of mental insanity, not produced by the *immediate* effects of intoxicating drinks, as not to have been conscious of the moral turpitude of the act, they should find him not guilty." Justice Hoy, also, in the great American case, declared criminal responsibility not to attach where the delirium is the "remote consequence" of voluntary intoxication, "superinduced by the antecedent exhaustion of the party, arising from gross and habitual drunkenness."

"However criminal, in a moral point of view, such an indulgence is,

and however justly he may be responsible for his acts arising from it, to Almighty God, human tribunals are generally restricted from punishing them, since they are not the acts of a reasonable being. Had the crime been committed when Drew (the defendant) was in a fit of intoxication, he would have been liable to be convicted of murder. As he was not then intoxicated, but merely insane from an abstinence from liquor, he cannot be pronounced guilty of the offense. The law looks to the immediate, not to the remote cause." In another recent case, a Federal Judge, of high authority, told the jury that if the defendant was so far insane as not to know the nature of the act, nor whether it was wrong or not, he is not punishable, although such delirium tremens is produced by the voluntary use of intoxicating liquors.

The following graphic delineation of the distinction between delirium tremens and insanity has been given by Justice Holroyd, of the English Bench, in John Burrough's case (1 Lewin, C. C., 75), and is also universally acknowledged as good law in the United States Courts. He says: "Drunkenness is not insanity, nor does it answer to what is termed an unsound mind, unless the derangement which it causes becomes fixed and continued by the drunkenness being habitual, and thereby rendering the party incapable of distinguishing between right and wrong."

As early as the year eighteen hundred and twenty, Tiedeman, Gmelin, and Majendie made some interesting and important investigations as to the poisonous nature of alcohol and its influence upon the blood and the system generally, detecting the presence of alcohol in the blood by its odor; and Sir A. Carlisle subsequently observed that the fluid found in the ventricles of the brain of drunkards had the smell, taste, and inflammability of gin. These inquiries and deductions naturally led the way to the determination of the pathology and distinctive symptoms of alcoholic poisoning, drunkenness, and delirium tremens arising from the excessive use of alcoholic liquors, and to the establishment of a definite differential diagnosis in reference to these diseases.

Leoville, in the year eighteen hundred and twenty-eight, was the first to promulgate the theory that delirium tremens could be distinguished by an exalted condition of the "vital powers of the brain, excited by molecules saturated with alcohol absorbed from the surface of the stomach and bowels, and carried into the current of the circulation." Recent researches, however, have established beyond dispute, by experiment and by daily experience, that the alcohol is instantaneously absorbed into the circulation, and operates as a direct poison on the nervous tissue through which the infected blood circulates.

As an inevitable consequence, the peculiar odor of alcohol impregnates the breath and permeates even the pores of the body, and imparts a pungent, spirituous aroma to the clothing. Post mortem analyses have revealed the presence of alcohol in the blood, the urine, the bile, the fluid of the serous membranes, the brain, and the liver.

Dr. Percy made some experiments, specially with relation to the rapid action of alcohol on the circulation. He injected strong alcohol (about ten degrees under proof) into the stomachs of two dogs, and scarcely two minutes after the injection all respiratory and cardiac movements ceased, and on autopsy, the stomach was found nearly empty and the blood highly charged with alcohol.

The combined testimony of French, British, German, and American physicians proves that in that state in which the system is peculiarly susceptible to delirium tremens, the blood is surcharged with unchanged and unused material, and contains at least thirty per cent more of car-

bon than in the normal state. The order of events by which this condition is brought about may be thus stated: The alcohol is immediately absorbed by the blood vessels, without change or decomposition. A portion of it is slowly eliminated by the lungs, liver, and kidneys, as alcohol simply, a portion remaining in the brain, liver, muscles, etc., for a time, undecomposed. The products of the decomposition, by absorption of the free oxygen of the blood, are water, acetic acid, and carbonic acid. The oxygen being thus diverted from its legitimate function, the exhalation of carbonic acid through the lungs is materially diminished, and the health correspondingly endangered by the lessened excretion of urea and uric acid. The presence of alcohol in such undue proportions is, beyond all doubt, the primary agent in the retention of this uneliminated matter; and the consequent impairment of health is intensified to a still greater degree by the increased frequency of functional acts, and subsequent depression thereby produced, due to the stimulant action of the alcohol.

The tissues generally atrophy, and while a particle of alcohol remains in the blood in its normal condition, it exercises a toxic or poisonous effect upon the whole nervous system through which the poisoned blood circulates. Hence, if a constant supply of alcohol be kept up, the alcoholism becomes permanent or chronic, and a series of acute paroxysms, usually in the form of delirium tremens, supervene; though occasionally, if the degeneration of the vital organs becomes excessive, fatal results ensue from asthenia or typhoid symptoms, accompanied by coma.

One of the chief and most essential elements in the causation of delirium tremens is the poisoning of the nerve-substance of the entire system, and more especially that of the brain. These effects produced on the cerebrum and medulla oblongata are repeated in the lungs, a constant sympathy existing between these organs. The accelerated motion and fevered condition of the blood, which is incessantly kept up in the case of the habitual drinker, is especially manifested by certain cerebral, thoracic, and other general phenomena in the loss of cerebral power, evinced by the absence of control over thoughts, emotions, and muscular action; the feeble and rapid action of the heart, the involuntary tremor and weakness of the muscles, and the mental agitation and terror which are ever on the increase. Should the patient eventually recover from these paroxysms, subsequent indulgence in similar excesses entails upon him, not only a persistent susceptibility to a recurrence of these phenomena, but inevitably and irrevocably gives rise to a permanent degeneration of all his physical and mental faculties, with a train of ills, such as cachexia, emaciation, marasmus, sexual incompetency, delirium, suicidal melancholy, permanent psychical aberration, and such like morbid phenomena, ending not unfrequently in epileptiform seizures, idiocy, or general paralysis.

And here a highly important consideration occurs to our mind, which has long been a subject of controversy, but has now received a tolerably decisive and reliable solution, viz: the transmission of this morbid appetite for intoxicating drinks from one generation to another, and the inheritance, by the drunkard's progeny, of the long and fearful catalogue of alcoholic sequelæ, in a chronic form. Morel, Whitehead, Adams, and other eminent authorities, affirm that the vice of alcoholic abuse is not only hereditarily transmissible, but that it also leads to congenital idiocy, or insanity, in even the third and fourth generation, and, furthermore, that in cases where the tendency to alcoholic excesses has an

hereditary origin, cure is, as a rule, impossible. Morel cites, as an example, a family that came under his own professional notice, in which the great-grandfather was a confirmed drunkard, and so marked and complete was the transmission of the disorder, that the race became totally extinct, under the recognized phenomena of alcoholic poisoning and degeneracy.

MORTALITY.

Some interesting and accurate statistics as to the mortality of the disease, and its relative frequency among either sex, have appeared in the British Army Reports, and afford valuable data for prognosis, while the facts there detailed are pregnant with suggestions as to the course which social reformers and philanthropists should take in arresting its progress. The report for eighteen hundred and fifty-three (prepared by Sir Alexander Tulloch), gives the undermentioned percentages of the mortality from delirium tremens in the home service (consisting of about seventy-eight thousand men), and the chief depots in the colonies (say about forty thousand troops), excepting India, which, for obvious reasons, we shall consider separately. We would remark, *en passant*, that, on investigation of the reports of the last twenty years, no perceptible change in the ratio has occurred, and these calculations may therefore be considered an accurate transcript of the mortality at the present period:

	Per cent.
Great Britain, infantry	17.6
Great Britain, cavalry	13.8
Bermuda	15.0
Canada	7.94
Gibralter	13.6
Malta	8.8
Nova Scotia	9.1
United States	8.0

The report and statistics furnished by the medical authorities at the General Hospital in Calcutta, and the Medical College Hospital, relating to and gathered from the records of five consecutive years, reveal the following facts:

1. That the disease occurs in women and men in the proportion of one to twenty-five, due rather to difference of habits than of sex.

2. That no evidence has been given to warrant us in asserting that the season of the year has any definite influence on the occurrence of the disease, though the mortality shows a marked augmentation during the eight hot months, the number of deaths being more than double the proportion occurring in the four cold months. These facts are borne out by our own experience in this hospital.

The accompanying table will show that the greatest mortality occurs between the ages of twenty-five and forty (a fact which is corroborated by the statistics of our delirium tremens wards), and also evidences that there is no uniformity in the proportion of deaths to the number of cases.

3. That in regard to age, the ratio is as follows:

Age.	Cases.	Deaths.	Per cent of deaths.
20 to 25	34	4	9.1
25 to 30	66	16	24.2
30 to 35	48	11	22.9
35 to 40	76	7	9.2
40 to 45	62	6	9.6
45 to 50	23	4	17.3
50 to 60	7	...	.....
60 to 65	5	1	.....

In delirium tremens the chief elements to be considered in the prognosis, are the absence or occurrence of sleep before the patient becomes exhausted, the character of the sphygmographic record of the pulse movements, and the introduction of an adequate amount of nourishment into the system. It has never been advanced or seriously believed that sleep is, in itself, curative. The disease has a certain course to run, its longer or shorter duration resting simply on its original virulence, the strength of the patient's constitution, and the degree of nutrition and support rendered by the regular and frequent supply of well selected food. In the case of an extremely hard drinker, or the complication of pneumonia, the chances of recovery are materially diminished. A first attack is much less dangerous, much less likely to culminate fatally, than a second, third, or fourth attack; but there are, of course, important exceptions and qualifications to this law, which can only be discovered by careful diagnosis. For example, a man of middle age, suffering under a first attack of delirium tremens, whose nervous system has been much enfeebled by chronic disease, or an insufficiency of feeding, but who has never, until recently, indulged to excess in drink, is extremely likely to succumb to the first attack. The fact that his system has been run down by mental anxiety and want of food, and that the eliminating organs (the kidneys especially), are unused to the duty of excreting large quantities of unchanged alcohol, render his recovery extremely improbable; whereas, on the other hand, a young man (a young sailor, for instance), whose first debauch has induced delirium tremens, may, from the inherent strength of his constitution, survive not only one, but two or three similar visitations.

SYMPTOMS AND COURSE.

The period of actual commencement, and the premonitory symptoms of this disease, have been points of controversy for many years. Dr. Lairdner denies that the proximate cause is the sudden withdrawal of potations, and affirms that it is the immediate product of a protracted debauch. The opposing theory simply asserts that a voluntary abstinence from alcoholic stimulants of some two or three days, precedes an attack of delirium tremens, and that the combined influence of the sudden withdrawal of alcoholic stimulants, and the absorbed alcohol remaining in the system, produces the catastrophe known as delirium tremens. To this latter opinion we subscribe, for there are many who are constantly taking small quantities of spirits, and who, though they

never become unconscious from its intoxication, considerably exceed their accustomed allowance, and continue in that course. The symptoms of delirium tremens generally occur in these persons from the second to the eighth or ninth day after a protracted debauch, and the premonitory symptoms are not unfrequently lost sight of.

The usual course may be thus described: The first warning of its approach is given by an attack of complete insomnia. Some pathologists divide the subsequent symptoms into several stages, but without apparent reason other than their individual tastes. The succession of symptoms after the premonitory insomnia, is usually in this order. The pulse is peculiarly slow and feeble, the hands and feet are cold and clammy, there is profuse sweating, with great disability, and nausea and vomiting in the morning. Anything which affects the mind or spirits produces a tremulous agitation. In vain the sufferer wooes sleep, it has fled from him. At the best, his slumbers are short and fitful snatches, broken in upon by visions and hallucinations of the most horrifying character. If he close his eyes but for a moment, he is relentlessly pursued by these phantom visitants; and even in broad daylight, with his eyes wide open, these creatures of his disordered imagination surround him on every side. During all this time there is so complete an absence of appetite in most cases, that little if any food is taken, a circumstance that contributes materially to the intensity of the disease. And now the anxiety and nervousness is exchanged for incoherence of speech and wild excitability of manner, sometimes evidencing itself in causeless anger, or in great terror at the terrific forms which people the chamber, and which he is continually endeavoring to push aside with his hands. He talks incessantly in a rambling manner. His pulse is quickened from one hundred to one hundred and thirty or one hundred and forty per minute; it is sometimes small and thready, occasionally soft and voluminous; and the form of the pulse waves closely resemble those in fevers of a typhoid type. Muscular tremor, from which the disease derives its name of *delirium tremens*, is by no means universally present. Craigie affirms that it is ever present, in cases of confirmed dram-drinkers, but in point of fact, it is only an exaggeration of the chronic tremors of the extremities, which are the inevitable penalty of hard drinking. But even in the absence of this muscular tremor, there is a constant restlessness, the patient shifts restlessly in the bed, constantly getting out if permitted. The pupils of the eyes are dilated, and in constant rolling movement. The temporal and carotid arteries throb violently, sometimes the face is flushed, but more often deadly pale. The tongue is tremulous, and protruded jerkily, is ordinarily covered with a yellowish fur, though sometimes it is clean, red, and glassy, or again, brown, dry, and cracked. After this state of things has continued for three or four days, the patient passes into a drowsy condition, from which he awakens to a state of comparative convalescence, or, in the event of adverse complications, with an augmentation of the delirium. In other cases, the patient, in the midst of violent delirium, with great excitability, suddenly collapses; the pulse becomes hurried, intermittent, and thready, the features pinched and ghastly, the breathing gasping, and death speedily ensues.

The stage of convalescence, once established, presents nothing particularly requiring description. Should a relapse, however, occur, he passes into a comatose condition, with muttering delirium, eyes open, staring, and fixed; the restless movement of the limbs more distinctly

marked; picking at the bedclothes; or, possibly, a profound, stertorous coma, or violent convulsions, which close the scene.

GENERAL SUMMARY OF SYMPTOMS.

Acute delirium and incoherence; stupor; strong suicidal impulse; hallucinations; dread; tremors of the tendons and muscles of the hands and limbs; watchfulness; absence of sleep; great frequency of pulse, one hundred to one hundred and forty per minute. Form of pulse waves resemble fevers of the typhoid type; furred condition of the tongue; cool, humid, or perspiring surface of the skin; saccharo-alcoholic odor; face flushed, or deadly pale, are the general phenomena. Slight tremor or faltering of hands and knees; tremulousness of voice; unaccountable and indescribable restlessness; sense of anxiety and presentiment; disturbed sleep; and loss of appetite. These symptoms generally occur after a sudden abstinence from liquors, and last for three or four days, when the patient ceases to sleep altogether. The above mentioned symptoms increase in severity, and delirium supervenes, at first only during the night, but gradually becoming constant, and necessarily the most prominent feature of the disease. The delirium, which is especially characterized by watchfulness, hallucination, terror, and apprehensive dread, lasts from three to six days, during which period the imagination of the patient conjures up the most horrible phantoms and visions; his countenance indicates unutterable anguish of mind and physical pain, and in the hope of escaping from his imaginary tormentors, he often endeavors by acts of violence to take his own life, and that of the persons within his reach.

TERMINATION.

After a time, sleep occurs (that is from three to six days from the period of attack); at first it is broken, then followed by a profound sleep of six or eight hours duration, from which the patient awakes improved.

TREATMENT.

In the treatment of delirium tremens, many points are to be taken into consideration, as the condition of the patient, the length of time the delirium has lasted, and the surroundings of the patient.

Our custom is to place this class of cases in a large room well ventilated, with about one thousand cubic feet of space for each patient.

Usually the patient is much fatigued on admission, and is in feeble physical health, and not infrequently there are complication, as bronchitis or pneumonia, and occasionally Bright's disease.

When no complication exists, we give a tepid bath. The patient is put to bed, and usually a *camisade* is required to restrain him.

The usual, and, perhaps, better treatment, is at once to place the patient on liberal and nutritious diet, as beef juice, cream, or essence, soups, milk, milk punch, egg-nog, etc.

If he is feeble, the reasons for giving stimulants are plain, though the delirium is caused by the same stimulant. Some recommend pure alcohol to be given instead of brandy, whisky, or even wine.

Of course, in administering stimulants to this class of patients, great and watchful care should always be exercised. The pulse is a safe guide, as stimulants should lower it and give it fullness. To quiet the

tremors and restlessness, opium serves a good purpose, administered by hypodermic injection.

The treatment which in all probability is the most effective, is a generous diet, full doses of fluid extract of conium during the day, to control the muscular action, and during the evening, hydrate of chloral, with tincture of hyoscyamus, the latter to be repeated until sleep is secured.

[*DOCUMENT C.*]

HOSPITALS FOR INEBRIATES.

Ten of these asylums already exist, some of which have been in operation for several years. Of these the principal are: 1. That at Media, near Philadelphia, opened about seven years ago, and containing twenty-five inmates. 2 The New York State Inebriate Asylum, Binghamton, opened about nine years ago, now capable of containing eighty individuals, but about to be opened for the reception of two hundred. 3. Washingtonian House, Boston, containing twenty four patients. 4. Shore Sound. 5. Ward Island. There are several others, at Chicago, Maryland, San Francisco, etc. In eighteen hundred and seventy-one, the grand total of admissions to some of these asylums amounted to five thousand nine hundred and fifty-nine. Into these establishments inebriates are admitted, either on committal by a magistrate for a specific period; after a process of examination before a Judge, and a jury summoned by him, the alleged drunkard being present, and being adjudged as requiring a curator and confinement; or on their own voluntary application and submission to existing rules and regulations. Of the total quoted, two hundred and fourteen, or nearly four per cent, come under the first category; one hundred and forty-four, or between two and three per cent, under the second; and five thousand five hundred and fifteen, or ninety-four per cent, under the third. It bears intimately upon the permanent efficacy of the measures pursued, that of the same number, one thousand three hundred and five, or twenty-three per cent, were admitted once; two hundred and twenty-seven, or nearly four per cent, were readmitted twice; ninety-seven, or nearly two per cent, were readmitted thrice. These Sanitaria, as they are gingerly called, are almost all under the superintendence of medical men, some of whom trust considerably to the employment of drugs during the collapse and excitement which follow excessive or prolonged drinking, and during the convalescence or reconstruction of the tissues of the body, to which much importance is attached; but none of them claim for any therapeutic agent the power of eradicating the habit or tendency, or of curing the disease originating therein. Great reliance is placed in the moral means brought to bear during seclusion, upon exercise, games, occupation in the surrounding grounds or country, in reading, writing, composition, social recreation, and the reciprocal influence of different dispositions associated together; and finally upon a nutritious diet, for it is affirmed that all great drinkers are also great eaters. These places have more the character of well conducted club houses, with a medical director, than of hospitals. After a brief probation, great confidence is reposed in the penitents, and much liberty allowed to them; certain of their number are intrusted with money, permitted to visit different parts of the country, and to mingle in society, as a test of their self control; certain others pursue their ordinary business in adjoining towns, but are held to be amenable to the rules and regimen of the hospital. As might have been predicated, from the experience of such classes obtained

in this country, these privileges are occasionally abused, though less frequently than might have been expected. Stimulants have been conveyed within the sacred precincts, it has become necessary to lock up individuals excited by their unhealthy craving, and it was proposed, in consequence of irregularities and disturbance in one house, to swear in the servants as constables. But, after making all deductions, what, it may be inquired, are the results claimed by those who have conducted this experiment? It should be premised that the authors whose works have supplied us with information, regard either the subsidence of the paroxysm of ebriosity, or such subsidence followed by a period of lucidity and temperance, characterized by convictions of the evil and danger, and degradation of relapse, and by a determination to avoid or resist temptation as a cure of the disease. This lucid interval varies in the opinion of different observers from days to weeks, months, years. The most modest estimate of the curability of drunkenness or dipsomania, for these are not distinguished, is that thirty-four or thirty-five per cent of those subjected to treatment are restored to permanent health. This is given on the authority of Drs. Parrish and Dodge, but fifty, sixty, even ninety per cent cures are claimed as crowning the labors of other physicians; or to place the statistics in another form, of two hundred and fifty-six patients received from October first, eighteen hundred and seventy-one, to eighteen hundred and seventy-two, into the Binghamton Asylum, one hundred and ninety-eight were discharged with great hopes of a permanent reformation, and fifty-eight unimproved; of two hundred and seventy-eight patients admitted into the Pennsylvania Sanitarium, in the same period, ninety were cured, one hundred and thirty improved, and thirty-five were regarded as incurable; of fifty-four patients admitted into the Maryland Asylum, at Baltimore, forty were discharged as having received benefit, ten as having received decided benefit; and of three thousand three hundred and twenty-two that have been received into the Washingtonian House since its commencement, "we have the satisfaction of knowing that a large proportion of them have become permanently reformed, have regained their former position, and become again exemplary members of society." This is not the place to expose the fallacy of the standard of cure here employed, further than to mention the irreconcilable discrepancy between the results recorded and those observed in this country, or to suggest the difficulty which must be experienced in tracing out the subsequent deportment of discharged patients, or to show how fugacious must be the change effected, further than to quote from the reports of the Maryland Asylum, that fourteen patients were admitted once, eight twice, and two three times, with an average of only two months' interval between each attack. Nor is it necessary to insist upon the opinion of eminent psychologists, such as Drs. Kirkbride and Ray, that these cures are not permanent or real, or that the reporters deal in "general assertions and flourishes." As, however, the whole subject has assumed a different phase in the United States, and as an animated controversy is now going on there as to whether habitual drunkenness be a sin or a disease, it becomes expedient to consider whether the existence of such retreats, dignified as hospitals, and administered with all the solicitude and benevolence, and supplied with all the delicacies and luxuries which the sorrowful and suffering require—may not act as premia or encouragements to indulgence; may be resorted to, chiefly to obtain, not reformation, but a clean bill of health and a whitewashed character; and, as workhouses are supposed to perpetuate pauperism, and infirmaries to diminish the carefulness of health

and cleanliness in those classes for whose benefit they are intended, so sanitaria may render respectable that evil which they are created in order to check and to crush. We have often speculated whether, if drunkenness were elected into the place of a virtue and a merit, as it was in chivalric days, when the strength of a man's head, his courage, his noblesse, were measured by the strength and the depth of his potations, what had become obligatory as a duty would not be shunned and violated, as is the case with many other obligations equally agreeable, and enjoining far fewer pains and penalties. In America, the whole matter of intemperance is treated as a national question, and the hopes of its solution are evidently founded upon the corrective influences of inebriate asylums, when the officers of these have been vested with powers of detaining their charges legally, until old habits have been rooted up, new dispositions, purposes, and tastes have been established; until new physical changes have likewise been effected in the constitution; and until reasonable grounds arise for reposing confidence in the self-control of the individual. With the view to consolidate the independent and desultory efforts already made or now in progress, of gathering and diffusing information, and of acting upon the opinion of the public and Legislatures, an association has been formed, somewhat similar to that devoted to social science in Britain, consisting of physicians, philanthropists, and those engaged in the management of charitable or punitive institutions. Of this body, three volumes of annual transactions are now before us. Besides the bare record of formal proceedings, these contain thirty-eight articles of various scope and merit, ranging from "A Brief Paper on the Pathological Influences of Alcohol, and the Nature of Inebriation," over almost every aspect and collateral issue of the subject, to "Practical Points relating to the Criminality, Repression, and Cure of Drunkenness and Dipsomania," which are deserving of serious attention, especially in Britain, where we are at a standstill; where we are not only doing nothing and proposing to do nothing, but where, in some directions, we are positively doing wrong.

The less utopian of our friends in America seem disposed to limit their expectations of triumphing over diseased propensities chiefly to what may be called curable cases, to recent cases, to cases in which there is a sincere desire and effort on the part of the patient to coöperate in the attempts made to effect his restoration. Should any measure be practically adopted in this country for the reclamation of dipsomaniacs, it might be prudent to confine the experiment, in the first instance at least, to these classes; for we cannot but dread the contamination which may arise from constant intercourse of depraved, confirmed, even of unstable drinkers, with those who still retain a recuperative power.

It must be borne in mind, that whatever may be proposed, we have to deal not merely with dram drinkers, but with those who seek excitement or oblivion by ether, eau de cologne, chloral, chlorodyne, chloroform, and opium, and that the effects upon the nervous system of each of these differ somewhat from those of the others. Enormous quantities of the latter drug are imported into this country, much larger, it is believed, than what are required for medicinal purposes, and it is suspected enter into the composition of many of the intoxicating beverages and cordials which are taken in comparative innocence and ignorance of their contents. In America it would appear that opium is largely consumed, and in certain of its forms is exposed for sale as a dram. "I know cases," says Dr. Parrish, "where persons are in the habit of purchasing a milder form of laudanum by the pint or quart, and using

it instead of alcoholic liquors" (p. 160, Minutes of Evidence). Nor are we exempt from the responsibility of a similar practice. Dr. Lyon Playfair, in the same page of the same book, "puts the case of three druggists, in one street in Manchester, who weekly supplied six hundred families of the poorer classes with opiates." Opium is said to be a remedy for intemperance, or a means by which abstainers sustain their self-denial, but it may be fairly conjectured that the cure is worse than the disease, involves greater hazards, and demands more stringent arrangements for its prevention and removal.

We were pleasantly surprised, but somewhat startled, by the announcement contained in Miss Emily Faithful's lecture, in our Mechanics' Institute, about two months ago, that, during a sojourn of nearly a year in the United States, she had only seen three drunken persons. Certain dark and discouraging revelations casting a shadow over our memory, we concluded that Miss Faithful must have kept remarkably good company, and must have passed her time in a paradise of undistilled fruits and flowers, and of unfermented golden grain. These revelations are to be found in blue books, but which, from their gloomy contents, should be called black; and in a large collection of reports, essays, etc., upon the subject of intemperance, abstinence, and inebriate asylums, which have been placed in our hands by a friend, a Dumfriesian, now resident in New York. It may be recollected that a Parliamentary committee, appointed under the auspices of the benevolent Mr. Dalrymple, M. P. for Bath, considered the wide subject of habitual drunkards, and their care and reformation, in eighteen hundred and seventy-two. From the inquiries of this body proceeded a vast mass of information, a report, and a bill. The bill proved abortive, its author has since died, and there is at present little prospect that legislation will be revived on the subject.

In the minutes of evidence now referred to, Mr. Dalrymple, who occupied two months in investigating the provisions for the reclamation of the inebriate class in America, states, in reply to the question "Has the greater stringency of the laws in force against intemperance there had the effect of diminishing drunkenness?" "If I may judge from the number of drunkards, I am afraid not." Two distinguished physicians, who have devoted their energies to the care and cure of drunkards and dipsomaniacs in America, were invited to submit their experience upon the bearing and prospects of the whole question to the committee. One of these, Dr. Parrish, physician of the Sanatarium, Media, Philadelphia, deposes that: "I do not know that prohibitory laws have been enforced anywhere. * * * The measures resorted to for evading the law are very curious and very numerous, and it has always been a question with me whether demoralization of society in creating a disrespect for the law, and all sorts of maneuvers to evade it, is not almost as great an evil as the drinking of liquor." And in reply to the question: "Is it your opinion, from the information you have received, that even if the prohibitory law is passed, it is rather hurtful than useful to the cause of temperance?" he said, "I think it is." He likewise quoted a letter from Mr. Otis Clapp, Boston, Assessor of the United States, Fourth District of Massachusetts, and one of the Vice Presidents of the American Association for the Cure of Inebriates, to the effect that "It is no easy matter to state to you the effects of the prohibitory laws and the punishment of drunkards, because the whole question is a sort of muddle.

The prohibitory laws were on the statute books many years, but as it was left to city officials to enforce them, they were not enforced, and we have nothing to settle in the matter of prohibition but what is unsettled, and the consequence is that regular drinkers can purchase what they want. In the rural districts, at a distance from the cities or large towns, it is generally difficult for drinkers to procure intoxicating liquors; but in the cities we have hundreds of poor men and women who keep no bars, but who retail spirits by the glass to customers whom they know, and never have on hand at one time more than one quart or gallon of spirits; they purchase as they need. Indeed, it is peddled from wagons like milk. In short, prohibition may have its advantages, but it is not here more than a partial success." (p. 155)

From the same document we learn that in this country, where no restrictions are in operation or have yet been attempted as to the sale or consumption of stimulants, in eighteen hundred and seventy there were thirty-eight thousand four hundred and forty-one individuals proceeded against by the police as habitual drunkards; that in the same year twenty-one thousand one hundred and thirteen cases of intoxication came under the cognizance of the police in Liverpool; that prisons, reformatories, workhouses, are constantly recruited from the inebriate classes; that fourteen or fifteen per cent of the cases of insanity admitted into public asylums owe their origin directly to intemperance; and that, in the opinion of the eminent psychologists or philanthropists who have contributed information to the committee, the morbid craving for stimulants is the most incurable form of mental disease. There must be added to this sad picture the less precise but equally trustworthy conviction that indulgence, even excessive indulgence, in alcohol, under various forms, is spreading widely and sinking deeply through the social customs of the inhabitants of the Continent; that beer, in larger quantities, is consumed by the Germans; that the juice of the grape has been substituted for the juice of the orange among the Italian peasantry; that the French have jilted their first loved sugar and water for brandy and the more poisonous absinthe; that large numbers of the besieged Parisians, especially their military defenders, were in a state of drunken delirium during the bombardment, and that many of the horrors and absurdities of the Commune could be legitimately traced rather to the abundance of strong drink than to the want of food or the obscuration of reason. We have presented these observations, not with the intention of pointing to a downward course, or of exposing the failure of the religious and moral means at our command in checking inebriety and dissoluteness, but for the purpose of introducing the question, "What has been done, or what is proposed to be done, by men of British origin, to mitigate the consequences of this evil, if all hope of eradicating it must be relinquished?"

We know and appreciate the existence of national confederations, leagues of abstainers, Good Templars, of lecturers and literature, all contending against, and to a certain extent successfully contending against, the ravages of intemperance; but we have never regarded the individuals engaged in this crusade as converts from the befoolment and befuddlement in which our race seems involved, but as sober members of the community, who, either from indifference to excitement or from self-control, have resisted the tendencies and temptations by which they were surrounded, and would have remained abstemious, without the aid of pledges, processions, or the paraphernalia of the middle ages; presenting what may be regarded by some as a prudish, but what is cer-

tainly a healthy example, in the midst of a lax or corrupt community. We know that the Church of England has spoken out nobly and loudly in the report of the Lower House of Convocation, as to what may be termed the social and domestic sources of intemperance; that the Church of Rome, by the voice of her highest dignitaries, by sermons, by the formation of societies; and that perhaps all religious bodies have, after their own fashion, contributed to admonish and to warn as to the great and growing evil of our day. Even the doctors, or three hundred of them, have published a sort of penitential confession that unconsciously they may have initiated a love for stimulants, especially among the fairer portion of their patients, by giving tinctures and toddy, or pick me-ups and champagne, when infusions or "plain cold water" would have answered the purpose. All this, as well as the improved usages of the affluent classes, is in the right direction, but affords no bulwark, no breakwater, against the tide of degradation which seems to be gaining upon us. Moralists, like medical men, are groping blindfolded after the means by which contagion may be prevented, and, in despair of success, are compelled to rest content with the suggestion of remedies, ameliorations, after the disease has been actually established, or during periods of temporary convalescence.

The treatment proposed in this country, as we learn from the minutes of evidence before alluded to, and from other sources, is that, having assumed an individual who has been found intoxicated three times within a given period to be an habitual drunkard, instead of decapitating him, as Charlemagne used to do at this stage, or fining and imprisoning for a brief space, as is the prevalent custom, a magistrate or Sheriff, as the case may be, shall be empowered to consign the offender for long periods, never less than a year, to a reformatory or penitentiary connected with an asylum, a prison, or a workhouse, or existing independently of all these. These depots are to be so situated and constructed that the inmates shall not be brought into contact with lunatics, criminals, or paupers; shall be placed under medical and moral management; shall be taught or employed in various trades and occupations; shall receive for themselves or their families, such proceeds of their labor as shall remain after their maintenance and supervision have been provided for; that they should be regularly visited and examined by public officials, and shall be discharged according to certain forms when they are believed to be recovered—in other words, when they have outlived the effects of former indulgence, the tyranny of former habits and temptations—when not only a new spirit, but a new or repaired physical organization have been created within them, and when they are supposed to be capable of safely and usefully resuming their former position and profession. The weight of authority and experience seems to be in favor of the proposition, that these reformatories should be altogether separated from and independent of other institutions; that for the indigent, they should be erected and maintained partly by local, and partly by national taxes; that for the affluent, their creation should be left to private enterprise; but that, under every circumstance, they should be licensed, regulated, and inspected, according to a special Act. It is almost needless to remark that this project is an outcome of the pernicious practice of placing drunkards in asylums, in those improvised, unrecognized, and we suspect very inefficient retreats scattered over the country, in islands, remote corners, and secluded spots, and superintended by self-constituted guardians of every grade, from the priest and physician, to the butcher and the bricklayer; or, in that extraordinary hospital of

all the moral ills and infirmities which flesh is heir to, Queensberry House. A curative home is the central idea of all the recommendations before us, but from this there radiate innumerable plans which may be regarded either as natural sequences or absurd excrescences. It has been mooted that the Danish mode of treating military drunkards, or the surfeiting the culprit with whisky while in prison, the deprivation of all other nourishment, society, occupation, etc., should be incorporated with, or should precede moral training. It has been gravely argued that the reformatory should be a village, that honor, truthfulness, and confidence in which inebriates are notoriously deficient, should take the place of bolts, bars, restraint, and captivity, and that, for stern warders or attendants, should be substituted enlightened companions and moral guides. Another cure is to be sought for in the spread of education, especially an instruction in physiology and in pointing out to the toper and tippler, not simply that he is doing wrong, but that he is burning up his vitals by a slow but sure process of spontaneous combustion. When all this chaff has been blown away by the wind of public discussion, there remained but two sound grains which promised to germinate and give some return—prolonged abstinence and detention. America, either borrowing from the example of our private speculations, or pressed by its own necessities, by inoperative and evaded permissive and optional bills, and by the prevalence of drunkenness, has anticipated the course suggested by the report, and has already instituted several homes or hospitals for inebriates, and encouraged by the supposed success of this arrangement, is clamorous for its extension.

CLIMATOLOGY AND CONSUMPTION.

By THOMAS M. LOGAN, M. D.

It has been claimed that the extension of civilization, the pursuit of agriculture, the drainage and reclamation of vast tracts of marshes, and particularly the felling of forests, have made great changes in the climate of the United States, especially in respect to temperature and rainfall. But whatever of truth there may be in the theories of man's agency in modifying climate, we cannot go beyond the results of the records, which have been made through a long series of years. Unsatisfactory as these records may be, they nevertheless constitute the only reliable data that we have for determining, whether either of the climatic conditions just referred to are increasing or diminishing—stationary or periodic.

From an examination of the results of all the observations which have been collected by Professor Henry and published in the reports of the Smithsonian Institution, we find that there has been no material change in the average rainfall, when long periods of time are compared, however the annual amount may vary. The irregularities in the successive yearly precipitation, though found to be very great in the different groups of the stations where the observations were made, and into which they were classed for the purpose of being systematically studied, nevertheless do not obliterate the appearance of conformity to general laws. The only decided indications of any material change are found in groups one and two, comprising New England and the Middle States, where the rainfall seems to have steadily increased since the year eighteen hundred and eighteen, in the very district which has been most stripped of its clothing of forest. Thus the power of augmenting the fall of rain which has been largely attributed to trees, vaguely by some, who confound such an attribute with their power of attracting mists, and boldly by others, who assert that rain now falls where trees have been planted in tracts formerly rainless, cannot longer be logically entertained. We learn positively from the mean results, as tabulated, that the rainfall during one hundred and thirty-seven years has undergone no change on this continent. The humidity of the great aerial currents is quite independent of local causes. The winds, charged with moisture collected in other regions, discharge their rain with indifference over wooded and unwooded districts, and the rainfall is not now more or less than it ever was.

The same conclusions may be drawn from the results of the temperature records, the fluctuations of which are found to be quite uniform throughout the entire country. Two or three years near eighteen hundred and twelve are historically known as cold years; and a reference to this period shows them to have been more extreme than any since, if we

except the present Winter of eighteen hundred and seventy-four–seventy-five, in the Eastern States. Next in severity come the cold years eighteen hundred and thirty-five–thirty-six, and eighteen hundred and thirty-six–thirty-seven. The next coldest groups were eighteen hundred and twenty-three–twenty-four, eighteen hundred and forty-three–forty-four, and eighteen hundred and seventy four–seventy-five. The high temperature groups are eighteen hundred and twenty-five–thirty, eighteen hundred and forty four–forty-eight, and eighteen hundred and fifty-three.

It would seem that there are two classes of non-periodic changes—one less frequent and affecting longer periods, and another causing changes above or below the general line of these long periods, and belonging to periods of a year or two. Further than this we find no results worthy of special mention from these long continuous observations over our vast territory, and hence infer that man's agency in influencing either the temperature or aqueous precipitation is, as far as we are able to judge, altogether insignificant. Similar inferences are deducible from the results of the observations made on the Pacific slope. In the comparatively brief records herewith presented, there is no evidence discernible of progressive or retrogressive movements, either in the temperature or in the rainfall. But the question of the rainfall, or of the temperature, does not settle the question of humidity. The humidity of the atmosphere depends not so much upon the amount of precipitation in rain as upon the rapidity of the process of evaporation and drainage; and it is here that man's agency proves instrumental in modifying climate. Our country, which was once largely covered with an unbroken forest, is now, to a great extent, denuded; the decrease of the forests being at the ratio of seven millions of acres annually. The rain, which was gradually conveyed by the leaves of trees to a dense undergrowth and layer of fallen leaves and vegetable mould, which absorbed it like a sponge, and whence it was transferred by the roots to the depths of the soil, now runs off by the nearest watercourses, leaving no supply of water during dry weather. (1) The restraint of evaporation by the dense shield afforded by forest shade being thus removed, the sun pours down upon the unprotected soil and rapidly evaporates the superficial water. The natural consequence of all this is an increased dryness of the atmosphere. This conclusion, which is arrived at from

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(1) It appears from statistics published in the report of the Agricultural Department in eighteen hundred and seventy-two, that California has a less area of forest in proportion to her farm lands than any other State in the Union. The whole area of the State is estimated at one hundred and twenty millions nine hundred and forty-seven thousand eight hundred and forty acres, of which one hundred and nine millions five hundred and twenty thousand seven hundred and fifty-five acres are not cultivated. The estimated area in woodland is nine millions six hundred and four thousand six hundred and seven acres, of which that which is included in farms is only four hundred and seventy-seven thousand eight hundred and eighty acres. The area in farms is estimated at eleven millions four hundred and twenty-seven thousand one hundred and five acres, of which only about 4.1 per cent is in woodland. Nevada has 6.4 per cent; Nebraska, 10.2; Kansas, 11.2; Iowa, 16.2; Illinois, 19.6. The proportion increases from the Pacific Coast towards the East to Indiana, which has 39.6 per cent, and then there is a gradual decrease to the Atlantic. The Southern States have a much larger proportion of forests. The proportion of forest to farm area in West Virginia is 51.1; Arkansas, 51.4; South Carolina, 53.4; Georgia, 54.6; Tennessee, 55; Alabama, 56; Florida, 60; North Carolina and Mississippi each 60.6 per cent. In the Territories the percentage—with one exception, that of Washington, which has 44.8 per cent—is quite small, being in Utah one tenth of one per cent; Montana and Wyoming 8.10 of one per cent; Colorado, 3.5; Dakota, 7.4; Idaho, 9.6, and New Mexico, 12.7. The scarcity of timber upon our farm lands adds largely to the strength of climatic reasons for an extended culture of forest trees.

general observation and practical knowledge, needs not the proofs that physical science affords by means of the wet and dry bulb thermometers. The facts are patent and intelligible to all, and can be measured in an uncovered district by the sensible diminution of a mountain stream after a day of intense sunshine. In California, on the eastern side of our great valley, in places where the upper lands have been cleared of trees, the rainwater descends impetuously in a torrent, leaving tiny streams, which flow steadily for many days, so long as the sky remains overcast, but cease altogether after a single day of sunshine.

In this connection, I would add that the rains are not now either lighter or heavier, or more fitful, than in former times, but there are fewer woods to restrain the drops, which unite to denude the rocks of their soil, and to form the mighty torrents, conveying thousands of tons of detritus to fill up the rivers, as witnessed every Winter season. It cannot be doubted but that an extensive planting of trees in the valleys, at the head of the main ravines, where cachement-areas of twenty-two thousand seven hundred and forty-two square miles (1) have been hypothetically plotted out, as seen in the accompanying map in this report, according to the projected irrigation plans of the United States Commission, would superinduce a more humid condition of the atmosphere, and lead to a more constant supply of water, in a region now arid and desolate, for more than six months in the year. The evaporation from such immense reservoirs as are contemplated by these surveys, would be simply enormous, and, if intercepted by the trees before being com-

(1) From report of the Board of Commissioners on the irrigation of the San Joaquin, Tulare, and Sacramento Valleys of California, eighteen hundred and seventy-four.

TABLE showing area in square miles of cachement basins.

Name of river or creek.	Cachement area.
Feather River	3,394
Kern River	2,382
American River	1,889
King River	1,853
San Joaquin River	1 631
Tuolumne River	1,514
Yuba River	1,329
Merced River	1,073
Cache Creek	1,025
Stanislaus River	971
Stony Creek	591
Cosumnes River	550
Putah Creek	584
Mokelumne River	573
Walker's Basin Creek	451
Calaveras River	390
Arroyo Los Gatos	343
Big Panoche Creek	319
Chowchilla River	304
Bear River	300
Posa Creek	278
Fresno River	258
Cantua Creek	164
Little Panoche Creek	136
Arroyo de Los Baños	125
Orestimba Creek	125
San Luis Creek	81
Arroyo del Puerto	79
Total	22,742

TABLE showing area in square miles in each county, and area of valley compared with area of mountains.

Name of county	Area of valley.	Area of mountains.	Total.
Alameda	6	74	80
Alpine	.....	508	508
Amador	.....	576	576
Butte	502	1,060	1,562
Calaveras	.....	1,037	1,037
Contra Costa	159	177	336
Colusa	1,117	1,503	2,620
El Dorado	.....	1,243	1,243
Fresno	3,270	5,560	8,831
Kern	2,798	2,642	5,440
Lake	.....	1,121	1,121
Mariposa	.....	1,418	1,418
Merced	1,312	607	1,919
Napa	.....	318	318
Nevada	.....	805	805
Placer	112	1,027	1,139
Plumas	.....	2,638	2,638
Sacramento	929	73	1,002
San Joaquin	1,271	121	1,392
Shasta	30	770	800
Sutter	530	74	604
Sierra	.....	723	723
Solano	600	186	706
Stanislaus	1,015	504	1,519
Tehama	880	2,053	2,932
Tulare	2,476	3,270	5,746
Tuolumne	.....	1,942	1,942
Yolo	653	403	1,056
Yuba	162	482	644
	17,822	32,916	50,658

pletely vaporized, the minute component vesicles of water would coalesce upon the leaves and branches, and fall in drops upon the earth.

This I regard as the principal mode by which trees may have a tendency to increase the general humidity of the climate; but, from sanitary considerations, this would be undesirable anywhere, except in the arid and semi-tropical zone of California. In no other respects, perhaps, has the influence of the superinduced dryness of the climate of the Eastern States, already alluded to, been more palpably demonstrated than in its results upon certain diseases; and no stronger evidence can be adduced in support of this conclusion than that afforded in an abstract, compiled from two tables, by Dr. Ham, of Dover, New Hampshire, to whose valuable paper, bearing on the whole subject under discussion, I am largely indebted.

From the first table, exhibiting the amount and ratio of sickness and mortality in the United States army from phthisis pulmonalis, during fifteen years, commencing in eighteen hundred and forty and ending in eighteen hundred and fifty-four, it is shown that temperature, considered by itself, does not have that controlling influence upon phthisis which has been attributed to it, but that *dryness* is the most important atmospheric condition.

The lowest ratio of cases of consumption occurs in New Mexico; there $1\frac{3}{10}$ per cent per one thousand soldiers; and the highest in the South Atlantic region, where it is $9\frac{2}{10}$ per cent per one thousand. The Gulf coast of Florida gives the next highest proportions, being $7\frac{2}{10}$ per one thousand of mean strength. New England has $4\frac{8}{10}$ per one thousand mean strength.

The second table referred to, constructed from the vital statistics of Boston, New York, and Philadelphia, and within the region of the modification of climate in respect to humidity, shows a relative decrease in the number of deaths from phthisis pulmonalis since eighteen hundred and ten.

IN BOSTON.

From 1810 to 1820	1 death from phthisis in 4 6-10 deaths.
From 1820 to 1830	1 death from phthisis in 6 deaths.
From 1830 to 1840	1 death from phthisis in 7 1-2 deaths.
From 1840 to 1850	1 death from phthisis in 7 deaths.

IN NEW YORK CITY.

From 1810 to 1820	1 death from phthisis in 4 1-2 deaths.
From 1820 to 1830	1 death from phthisis in 5 3-5 deaths.
From 1830 to 1840	1 death from phthisis in 5 9-10 deaths.
From 1840 to 1850	1 death from phthisis in 7 7-10 deaths.
From 1850 to 1855	1 death from phthisis in 8 7-10 deaths.

IN PHILADELPHIA.

From 1810 to 1820	1 death from phthisis in 6 4-10 deaths.
From 1820 to 1830	1 death from phthisis in 6 7-10 deaths.
From 1830 to 1840	1 death from phthisis in 7 4-10 deaths.
From 1840 to 1850	1 death from phthisis in 7 2-10 deaths.
From 1850 to 1855	1 death from phthisis in 8 2-10 deaths.

The same authority thinks that this falling off in the relative number of deaths from phthisis, during the last seventy years, obtains, also, in all the diseases of the respiratory system, and is largely due to the comparative absence of ozone, which exists in large proportion in a humid atmosphere.

Dr. Pfaff gives (1) an account of his observations at Plauer, in Saxony, at one thousand and fifty German feet above the level of the sea. He has not found the direction of the wind influencing the presence of ozone. He has found stormy weather exceedingly favorable to its production; the ozone appearing immediately in large quantity during a storm suddenly coming on, after a succession of fine weather unaccompanied by ozone. Test paper, which had long remained unchanged, would then denote eight degrees of ozone; while as soon as the storm had passed away all reaction on the test paper would cease—the storm seeming to bring and take away with it the ozone. Similar but less rapid increase in the ozone was observed during mere changes of weather, as when fine weather of long duration was followed by rain. As a general rule moisture was favorable to the development of ozone. Little or no influence was exerted by temperature; the proportion of ozone not being greater in Winter than in Summer.

The following are Dr. Pfaff's conclusions with respect to the influence of ozone:

1. A large proportion of ozone in the atmosphere acts mischievously on diseases of the respiratory organs.
2. The ozone of the air exerts little or no influence on epidemic diseases, provided that these are not complicated with catarrhal affections.
3. A large amount of ozone in the air, whatever may be the direction of the wind, favors the development of inflammatory affections, and especially of tonsilitis.
4. Other diseases besides those mentioned do not seem to be influenced by the amount of ozone.

In the presence of such facts and deductions, the planting of trees in California may appear inconsistent. It must be remembered, however, that the extreme aridity of the climate is very peculiar—in fact, it is too dry; and it need only be remarked here, that this extreme does not belong to the Summer season alone. The mean relative humidity of the five rainy months (October to March) in Sacramento is 72°, and at no time ever reached complete saturation. During the dry season the moisture generally amounts to less than fifty per cent; the temperature of evaporation during the hottest part of the day not unfrequently reaching 25° to 30°. Taking the mean of the whole year, this percentage is 66°. Now, as the most agreeable and salutary amount of humidity (2) is between seventy and eighty per cent, such a great deviation from this healthy standard as is here met with, cannot but be fraught with more or less danger to the imprudent. The equability of any climate is largely dependent upon the presence of aqueous vapor. The most potent of the sun's heating rays are largely intercepted in an atmosphere which is, to any extent, charged with watery vapor; and hence it is that the entire solar force is unfelt in our coast region, where the evaporation from the sea perpetually supplies an effectual screen. The intensity of the sun's direct rays, as measured by a blackened-bulb thermometer, *in vacuo*, fluctuates from 120° to 135°. The variations appear to coincide distinctly with the amount of atmospheric humidity, the thermometer rising to 148° in our great valley

(1) Vol. 46 of Braithwaite's Retrospect.

(2) Parks' Practical Hygiene.

during the arid northwest winds, and seldom attaining more than 125° during our humid southeast winds. The dangerous difference between sunshine and shade is, therefore, due to the absence of aqueous vapor. There is no cold shade in an atmosphere reasonably humid, inasmuch as the contained aqueous vapor intercepts and diffuses the excess of solar heat, and renders the shade safe and temperate. But when the air is too dry to intercept any great quantity of solar heat, the direct rays of the sun become oppressively hot, whilst the shade is dangerously cold.

The vapor of water has also another use. When the atmosphere is dry and the sun is gone, the earth rapidly loses heat by radiation into space. A moist atmosphere, on the contrary, is to a certain extent impervious to the passage of the rays of heat, and a moderate temperature is maintained throughout the night. In the Summer climate of the interior valleys of California this shield of vapor is absent, and hence we experience great extremes of night and day, and of Summer and Winter. While referring to the accompanying tables to sustain what is advanced, we would here remind the general reader of the nature and value of mean temperatures. It must be understood that they are merely averages founded upon columns and pages of individual observations. Mean temperatures merely give the *amount* of heat observed in given periods, without mention of the manner in which it is distributed, and the consequent variations to which a climate may be subject. A moderate mean annual temperature may, for instance, represent a climate like that of Santa Barbara, wherein night and day, Winter and Summer, closely approximate in the quantity of apportioned heat; and also a climate such as that of Nice and Mentone, in France, regularly or irregularly subject to heat too intense in Summer to be encountered by invalids, and also too frosty cold in Winter. Nothing is more common than for those who consult meteorology to seize upon the annual mean temperature as a solitary point of comparison whereupon to ground their judgment, not discerning that therein the excess of Summer heat is made to compensate for deficient Winter warmth.

Now the great reduction, by rapid radiation of heat after the maximum is reached, is the most striking as well as the most important feature, from a sanitary point of view, of the interior climate of California. The extreme monthly ranges prove that the greatest transitions occur from May to October, inclusive, which is the rainless period. The mean maximum for these six months is 89.73°, and the mean minimum 40.63°. Consequently, the mean extreme Summer range is 49.10°. But this does not exhibit the extreme monthly ranges, which sometimes reach beyond 50° during our arid north winds, when the thermometrograph leaves its mark in the neighborhood of 100°. However high the wave of temperature may tower up, under the influence of a vertical sun and almost vaporless atmosphere, it sinks proportionately low at night, rendering it, by contrast, so cold and chilling that blankets become indispensable for comfort. This Asiatic feature of the climate, while it imparts a resiliency or elasticity to animal life, is at the same time treacherous to the health, especially of the feeble and delicate, and often acts as an exciting cause of disease. We thus are enabled to understand why an attack of intermittent is sometimes brought about by the removal of an inhabitant of the interior valleys to San Francisco, or to a cool mountain region. In fact, every sort of cooling down, dry as well as moist, especially if the body has been

particularly heated, may give rise to the development of malarial affections.

Paradoxical as it may seem, after what has been advanced in the preceding pages of this report respecting the well-recognized agency of humidity as one of the factors of malaria, to recommend measures calculated to promote this very humidity, still it must be remembered that excesses of heat and aridity are the great exigencies in our present sanitary forecastings. Do what we will and all we can, our labors would prove but pigmy efforts towards transforming those grand climatic features which are due to influences far beyond our control. To provide against extremes, and to temper the burning aridity of our treeless plains, which, during a northwest wind in Summer, compares almost at times with that of the Desert of Sahara, is a very different thing from attempting to induce that excess of moisture due to cosmic causes, and which sometimes imparts to the climate of our Atlantic cities the deadly characteristics of the Terras Calientes of the Mexican coast. All we can hope to effect is to equalize, to a certain extent, the temperature in sunshine and shade, and, through the instrumentality of arboriculture, to retard, if not prevent, the action of the sun in quickening into activity noxious fermentation. It has been my purpose to show that our climate possesses inherent capacity for sanitary modifications; and knowing that it may be ultratropical at times, during our dry Summer, it is incumbent on me to prepare for all the contingencies of such a condition, by suggesting every possible safeguard against the dangers to which the people may be subjected at such periods.

The following tables, of the results of meteorological observations for a series of years at Sacramento and San Francisco, being representative types of the interior valley and coast climates of California, are worthy of close study and attention:

TABLE NO. 1 OF RAINY DAYS AND RAIN IN SACRAMENTO.

Arranged according to the seasons, showing the amount of rain, in inches, of each month during twenty five years, and for each rainy season; also, the number of rainy and foggy days during which the amount of rain fell in each month in the same period.

Months.	1849.		1850.		1851.		1852.		1853.		1854.		1855.		1856.		1857.	
	Quantity.....	Days.....	Quantity.....	Days.....	Quantity.....	Days.....	Quantity.....	Days.....	Quantity.....	Days.....	Quantity.....	Days.....	Quantity.....	Days.....	Quantity.....	Days.....	Quantity.....	Days.....
September.....	0.250	.....	0.000	.....	1.000	1	0.003	.....	0.000	1	sprinkle.	1	sprinkle.	.....	sprinkle.	1	0.000	.....
October	1.500	3	0.000	.....	0.180	2	0.000	1	0.005	1	1.010	11	0.000	.....	0.195	6	0.655	3
November.....	2,250	8	sprinkle.	1	2.140	5	6.000	12	1.500	5	0.650	2	0.750	9	0.651	10	2.406	10
December.....	12.500	12	sprinkle.	2	7.070	14	13.410	20	1.540	4	1.150	8	2.000	13	2.396	13	6.632	13
	1850.		1851.		1852.		1853.		1854.		1855.		1856.		1857.		1858.	
January	4.500	15	0.650	5	0.580	4	3.000	12	3.250	6	2.670	15	4.919	16	1.375	14	2.444	21
February.	0.500	5	0.350	4	0.120	4	2.000	6	8.500	14	3.460	7	0.692	6	4.801	17	2.461	13
March.....	10.000	7	1.880	7	6.400	14	7.000	8	3.250	4	4.200	9	1.403	5	0.675	10	2.878	13
April.....	4.250	3	1.140	3	0.190	3	3.500	7	1.500	9	4.320	9	2.132	8	sprinkle.	1	1.214	3
May.....	0.250	.....	0.690	2	0.300	1	1.450	4	0.210	4	1.150	6	1.841	4	sprinkle.	3	0.203	4
June.....	0.000	.....	0.000	.....	0.000	.....	0.001	1	0.310	2	0.010	1	0.033	1	0.350	2	0.098	2
July	0.000	.....	0.000	.....	0.000	.....	0.001	2	0.000	.....	0.000	.....	0.000	... ..	0.012	1	0.000	.....
August	0.000	.....	0.000	.....	0.000	.....	0.000	.....	sprinkle.	1	0.000	.....	0.000	.....	sprinkle.	1	sprinkle.	4
Totals.....	36.000	53	4.710	24	17.980	48	36.365	73	20.065	51	18.620	69	13.770	62	10.455	79	18.991	86

Rain Table No. 1—Continued.

Months.	1858.		1859.		1860.		1861.		1862.		1863.		1864.		1865.	
	Quantity.....	Days	Quantity.....	Days	Quantity.....	Days	Quantity.....	Days	Quantity.....	Days	Quantity.....	Days	Quantity.....	Days	Quantity.....	Days .....
September.....	sprinkle.	5	0.025	3	0.063	2	0.000	.....	0.000	.....	0.003	1	0.004	1	0.080	4
October	3.010	5	0.000	.....	0.914	9	sprinkle.	1	0.355	6	0.000	.....	0.120	2	0.480	5
November.....	0.147	11	6.485	15	0.181	5	2.170	12	0.005	2	1.490	7	6.718	9	2.427	9
December.....	4.329	17	1.834	17	4.282	20	8.637	22	2.327	11	1.815	10	7.867	16	0.364	9
	1859.		1860.		1861.		1862.		1863.		1864.		1865.		1866.	
January	0.964	19	2.310	15	2.668	10	15.036	20	1.733	10	1.077	7	4.776	13	7.699	18
February	3.906	18	0.931	14	2.920	9	4.260	11	2.751	11	0.186	2	0.712	6	2.010	11
March.....	1.637	14	5.110	17	3.320	7	2.800	15	2.360	10	1.303	12	0.481	7	2.018	11
April.....	0.981	6	2.874	8	0.475	4	0.821	9	1.693	9	1.080	4	1.370	3	0.476	6
May.....	0.981	4	2.491	10	0.590	3	1.808	9	0.355	2	0.742	8	0.460	2	2.252	5
June.....	1.037	.....	0.017	2	0.135	4	0.011	.....	0.000	.....	0.087	3	0.000	.....	0.100	2
July.....	0.000	1	0.549	3	0.000	.....	0.000	1	0.000	1	0.000	.....	0.004	3	0.018	3
August.....	0.030	.....	0.000	.....	0.000	.....	0.006	.....	0.000	2	0.085	3	0.000	.....	0.000	.....
Totals.....	16.041	100	22.626	104	15.548	73	35.549	100	11.579	64	7.868	52	22.512	62	17.924	83

Rain Table No. 1—Continued.

Months.	1866.		1867.		1868.		1869.		1870.		1871.		1872.		1873.		1874.	
	Quantity.....	Days	Quantity.....	Days	Quantity.....	Days	Quantity.....	Days	Quantity.....	Days	Quantity.....	Days	Quantity.....	Days	Quantity.....	Days	Quantity.....	Days .....
September.....	0.000	1	0.006	1	0.000	.....	sprinkle.	1	0.000	.....	0.001	1	0.002	2	0.000	.....	0.050	1
October.....	0.001	1	0.000	1	0.000	3	2.120	2	0.020	2	0.210	1	0.220	2	0.310	4	2.257	8
November.....	2.426	8	3.806	6	0.774	5	0.850	5	0.584	6	1.220	8	1.930	4	1.210	5	3.801	9
December.....	9.511	21	12.850	18	2.612	11	1.962	7	0.971	6	10.590	22	5.388	13	10.009	21	0.440	17
	1867.		1868.		1869.		1870.		1871.		1872.		1873.		1874.		1875.	
January	3.440	15	6.036	17	4.790	14	1.371	9	2.075	8	4.040	11	1.230	10	5.200	14	8.705	14
February.....	7.104	9	3.147	9	3.630	5	3.236	11	1.919	11	4.740	18	4.360	17	1.856	9	.....	.....
March.....	1.010	6	4.348	12	2.942	12	1.642	6	0.690	8	1.936	10	0.551	4	3.050	10	.....	.....
April	1.805	7	2.306	9	1.240	5	2.120	7	1.454	6	0.610	6	0.512	4	0.890	10	.....	.....
May.....	0.008	1	0.270	2	0.648	2	0.270	1	0.756	5	0.280	3	0.000	.....	0.370	6	.....	.....
June.....	0.000	1	sprinkle.	3	0.008	1	sprinkle.	1	0.001	1	0.025	1	0.002	1	0.002	2	.....	.....
July.....	0.000	1	0.000	.....	0.000	.....	sprinkle.	1	0.000	.....	0.000	.....	0.015	2	0.001	1	.....	.....
August	0.000	1	0.000	.....	0.000	.....	0.001	1	0.000	.....	0.000	2	sprinkle.	1	0.000	.....	.....	.....
Totals.....	25.305	72	32.769	78	16.644	58	13.572	57	8.470	53	24.052	83	14.208	60	21.898	82	.....	.....

RAIN TABLE NO. 2, FOR SAN FRANCISCO.

Prepared by THOMAS TENNENT.

Months.	1849.		1850.		1851.		1852.		1853.		1854.		1855.		1856.		1857.	
	Quantity.	Days.	Quantity.	Days.	Quantity.	Days.	Quantity.	Days.	Quantity.	Days.	Quantity.	Days.	Quantity.	Days.	Quantity.	Days.	Quantity.	Days.
July	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.02	1	.....	.....
August	.....	.....	.....	.....	.....	.....	.....	.....	.04	1	.01	1	.....	.....	.....	.....	.05	2
September	.....	.....	0.33	4	1.03	1	.....	.....	.46	4	.15	3	.....	.....	.07	2	.....	.....
October	3.14	3	.....	.....	.21	2	.80	1	.12	2	2.41	9	.....	.....	.45	5	.93	3
November	8.66	8	0.92	7	2.12	5	5.31	12	2.28	12	.34	2	.67	7	2.79	9	3.01	11
December	6.20	12	1.05	4	7.10	14	13.20	20	2.32	11	.81	3	5.76	15	3.75	12	4.14	8
	1850.		1851.		1852.		1853.		1854.		1855.		1856.		1857.		1858.	
January	8.34	15	0.72	5	.58	4	3.92	11	3.88	10	3.67	11	9.40	13	2.45	7	4.36	8
February	1.77	5	0.54	4	.14	4	1.42	5	8.04	16	4.77	10	.50	4	8.59	15	1.83	8
March	4.53	7	1.94	9	6.68	14	4 86	6	3.51	11	4.64	12	1.60	5	1.62	6	5.55	8
April	0.46	3	1.23	8	.26	3	5.37	8	3.12	9	5.00	10	2.94	6	.....	.....	1.55	4
May	.....	.....	0.67	3	.32	1	.38	7	.02	1	1.88	6	.76	3	.02	3	.34	3
June	.....	.....	.....	.....	.....	.....	.....	.....	.08	2	.....	.....	.03	1	.12	1	.05	1
Totals	33.10	53	7.40	44	18.44	48	35.26	70	23.87	79	23.68	67	21.66	54	19.81	61	21.88	56

Rain Table for San Francisco—Continued.

Months.	1858.		1859.		1860.		1861.		1862.		1863.		1864.		1865.		1866.	
	Quantity	Days	Quantity	Days	Quantity	Days	Quantity	Days	Quantity	Days	Quantity	Days	Quantity	Days	Quantity	Days	Quantity	Days
July	.05	2	.....	.....	.21	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
August	.16	2	.02	1	.....	.....	.....	.....	.....	.....	.....	.....	.21	3	.....	.....	.....	.....
September	.....	.....	.03	1	.....	.....	.02	1	.....	.....	.03	1	.01	1	.24	2	.11	2
October	2.74	4	.05	1	.91	12	.....	.....	.40	2	.....	.....	.13	3	.26	4	.....	.....
November	.69	5	7.28	15	.58	3	4.10	12	.15	3	2.55	5	6.68	8	4.19	10	3.35	12
December	6.14	14	1.57	6	6.16	21	9.54	16	1.80	8	1.80	8	8.91	18	.58	8	15.16	18
	1859.		1860.		1861.		1862.		1863.		1864.		1865.		1866.		1867.	
January	1.28	4	1.64	8	2.47	8	24.26	18	3.63	9	1.83	5	5.14	9	10.88	16	5.16	15
February	6.32	18	1.60	7	3.72	8	7.53	10	3.19	10	.....	.....	1.34	8	2.12	9	7.20	9
March	3.02	11	3.99	13	4.08	8	2.20	11	2.06	8	1.52	9	.74	4	3.04	12	1.58	7
April	.27	4	3.14	8	.51	4	.73	9	1.61	9	1.57	4	.94	3	.12	1	2.36	8
May	1.55	4	2.86	11	1.00	3	.74	5	.23	2	.78	5	.63	2	1.46	6	.....	.....
June	.....	.....	.09	2	.08	2	.05	1	.....	.....	.....	.....	.....	.....	.04	1	.....	.....
Totals	22.22	68	22.27	73	19.72	70	49.27	83	13.62	52	10.08	37	24.73	59	22.93	69	34.92	71

Rain Table for San Francisco—Continued.

Months.	1867.		1868.		1869.		1870.		1871.		1872.		1873.		1874.	
	Quantity.	Days.	Quantity.	Days.	Quantity.	Days.	Quantity.	Days.	Quantity.	Days.	Quantity.	Days.	Quantity.	Days.	Quantity.	Days.
July	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.03	2	.....	.....
August	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.15	3	.....	.....
September	.04	1	.....	.....	.12	1	.03	1	.03	2	.14	1	.....	.....	.08	2
October	.20	1	.15	3	1.29	2	.....	.....	.11	2	.21	1	.68	2	2.73	8
November	3.41	6	1.18	5	1.19	5	.43	4	3.72	9	2.62	3	1.31	6	5.92	7
December	10.69	18	4.34	11	4.31	7	3.38	8	16.74	14	7.25	10	10.12	20	.28	4
	1868.		1869.		1870.		1871.		1872.		1873.		1874.		1875.	
January	9.50	17	6.35	14	3.89	9	3.07	7	4.22	10	2.17	8	4.85	14	6.97	12
February	6.13	9	3.90	5	4.78	9	3.86	10	6.97	20	4.24	17	1.83	10	.20	*1
March	6.30	12	3.14	12	2.00	8	1.29	8	1.64	10	.78	4	3.55	15	.....	.....
April	2.31	9	2.19	5	1.53	4	1.93	5	1.10	7	.52	3	.04	7	.....	.....
May	.03	2	.08	2	.20	2	.21	3	.16	3	.01	1	.34	4	.....	.....
June	.23	3	.02	1	.....	.....	.....	.....	.02	2	.08	1	.08	2	.....	.....
Totals	38.84	78	21.35	58	19.31	47	14.10	46	34.71	79	18.02	49	23.98	85	16.18	*34

* Up to ninth of February.

TABLE No. III.

Mean temperature of each month at Sacramento, since eighteen hundred and fifty-two, deduced from three daily observations; also, the mean temperature of each year, and the average of twenty-two years.

Months.	1853.	1854.	1855.	1856.	1857.	1858.	1859.	1860.	1861.	1862.	1863.	1864.
January	43.00	43.00	43.71	48.02	48.54	45.03	44.87	46.20	47.12	46.41	46.87	49.17
February	50.00	51.00	52.50	52.64	50.25	52.24	50.49	49.83	52.17	47.50	47.96	53.65
March	59.80	53.00	54.82	57.03	56.42	53.74	51.47	53.30	55.05	53.58	57.62	56.07
April	61.00	60.00	58.06	58.80	63.27	59.80	57.11	57.82	60.65	58.05	59.46	62.12
May	68.00	62.00	60.20	63.91	65.51	65.19	63.03	58.38	63.70	61.25	67.14	68.48
June	77.00	67.00	71.10	71.06	71.93	69.43	74.85	65.64	66.18	69.33	69.08	71.10
July	75.00	80.63	72.55	75.12	71.45	70.81	69.07	73.17	73.57	73.19	75.63	74.84
August	71.00	69.47	73.04	69.59	71.31	70.57	67.16	73.50	69.73	75.00	70.66	74.70
September	76.00	65.05	68.01	70.93	67.93	68.90	65.89	67.59	67.78	70.41	68.98	69.83
October	78.00	60.01	63.01	58.04	61.49	59.51	63.28	59.76	59.91	67.60	62.84	64.54
November	53.00	55.05	50.65	52.18	53.24	54.23	54.05	53.47	53.60	53.15	52.74	53.53
December	48.00	47.93	45.99	43.86	47.37	44.47	43.52	49.34	50.93	46.44	46.49	50.18
Mean	62.57	59.51	59.47	60.10	60.73	59.49	58.73	59.01	60.12	60.16	60.35	62.82

TABLE No. III—Continued.

MONTHS.	1865.	1866.	1867.	1868.	1869.	1870.	1871.	1872.	1873.	1874.	Average, 22 years.
January	47.42	46.52	48.18	47.00	47.65	48.61	48.33	48.48	52.70	45.70	46.47
February	49.04	53.48	47.80	50.50	49.90	51.10	49.40	53.27	48.21	49.30	50.55
March	53.60	54.18	50.67	55.00	53.63	53.05	56.00	56.77	56.84	52.90	54.41
April	59.35	61.89	59.70	60.10	59.00	57.00	59.25	57.60	60.00	59.50	59.52
May	70.22	63.06	64.39	64.25	64.20	61.02	61.50	67.00	67.87	64.70	64.31
June	73.47	72.16	70.30	69.50	70.82	69.33	70.10	69.20	71.73	70.20	70.46
July	74.01	76.23	73.75	73.80	74.41	71.76	70.20	71.42	73.19	72.80	73.48
August	71.74	76.03	71.74	71.20	71.26	72.57	72.00	73.13	66.30	70.90	71.48
September	68.84	72.16	68.84	68.30	69.90	68.00	67.43	68.83	69.90	70.70	69.10
October	63.07	65.20	62.72	61.96	63.11	63.61	62.20	58.90	61.40	61.70	62.58
November	56.90	53.84	54.80	53.90	54.00	53.37	50.23	51.16	57.50	53.93	53.56
December	44.13	50.17	46.82	47.00	46.52	45.51	48.67	48.97	47.70	45.00	47.05
Mean	60.98	62.08	59.90	60.11	60.36	59.58	59.60	60.43	60.66	59.78	60.25

TABLE No. IV.

Showing the mean relative humidity for thirteen years, at Sacramento; saturation being one hundred.

Month.	Amount.
January	78.82 per cent.
February	74.08 per cent.
March	78.38 per cent.
April	66.09 per cent.
May	63.29 per cent.
June	58.48 per cent.
July	56.14 per cent.
August	57.66 per cent.
September	58.83 per cent.
October	61.88 per cent.
November	69.65 per cent.
December	76.60 per cent.
Mean for thirteen years	66.67 per cent.

TABLE No. V.

Showing the mean of all the highest readings by day, and all the lowest readings by night, as noted by the thermometrograph, during ten years, at Sacramento.

Month.	Mean of all highest readings by day.	Mean of all lowest readings by night.	Mean daily range during ten years.
	°	°	°
January	60.19	31.00	29.19
February	64.69	34.30	30.39
March	70.09	37.70	32.39
April	79.90	43.20	36.70
May	83.70	46.80	36.90
June	93.30	52.20	41.30
July	95.00	55.20	39.80
August	93.20	45.20	48.00
September	89.90	52.11	37.79
October	83.30	43.30	40.00
November	70.50	36.70	33.80
December	60.70	34.90	25.80
Annual average	78.70	42.68	36.02

TABLE No. VI.

Showing the mean temperature of each month, for twenty-four years, in San Francisco (Dr. Gibbons), and of each month in twenty-two years, in Sacramento (Dr. Logan).

Month.	Twenty-four years, San Francisco.	Twenty-two years, Sacramento.
	°	°
January	48.90	46.47
February	52.05	50.55
March	54.73	54.41
April	55.78	59.52
May	57.83	64.31
June	59.73	70.46
July	61.00	73.48
August	61.84	71.48
September	61.40	69.10
October	60.00	62.58
November	56.18	53.56
December	50.33	47.05
Mean for twenty-four and twenty-two years	56.65	60.25

THE CLIMATE OF SAN FRANCISCO.

By HENRY GIBBONS, Sr., M. D.

The reader will be able to obtain, by an analysis of the accompanying tables, a tolerably fair idea of the climate of San Francisco. The following conclusions may be stated:

The year covered by the report was decidedly colder than the average—*i. e.*, one and a half degrees, which is one and a half degrees for every day in the year.

January, the coldest month (forty-seven degrees), was but thirteen degrees colder than August (sixty degrees), the warmest month.

The highest temperature in any one month was is June (eighty-five degrees); the next highest in May (eighty-two degrees); but in no other month did the thermometer rise above seventy-six degrees. The warmest weather of the year is generally in September; sometimes in October, when the sea breeze abates.

The warmest night of the year was sixty-six degrees (at ten P. M.), and the warmest morning was sixty eight degrees (at sunrise). This is a fair representation of the climate from year to year. It is very seldom warm enough in the evening to sit out of doors with comfort, and never too warm at night to sleep without blankets.

The change in temperature from noon to night is rapid, though the range is small, being only eight or ten degrees. The temperature falls but little during the night. This is the case not only during the prevalence of the sea breeze, which prevents both noonday heat and extreme cold at night, but in the Winter months, when there is no sea breeze.

East winds are almost unknown. The duration of east and northeast winds for the entire year was but five days. From the first of June to the first of October, the wind scarcely ever is from the northern half of the compass for a single moment. The south and southeast wind prevails only in the Winter, and is the rain-wind.

Table III shows that mornings and evenings are comparatively calm throughout the year, and that the reverse occurs in the afternoons during the Summer months. The sea breeze is seldom unpleasant till eleven or twelve o'clock, and it generally subsides at sunset.

Table IV shows that the sky is much overcast in July, August, and September, which are the months in which the mist comes in from the ocean. The sky may be said to be fickle at all times in regard to clouds, seldom remaining completely obscured for twenty-four successive hours. About one half the days in the three months above named have more or less mist, which appears toward sunset, and disappears mostly in the night.

The quantity of rain was about the average, though it was distributed over a greater number of days than common. In this respect the Winter, so called, was exceptionably wet. The quantity of rain in June was extraordinary. The whole quantity for twenty-four years, in the months of June, July, and August, was two inches, or an average of

less than three hundredths of an inch per year to each month. The smallest quantity of rain in any season for twenty-four years was in eighteen hundred and fifty–fifty-one, seven inches. The greatest quantity was in eighteen hundred and sixty-seven–sixty eight, 40.5 inches.

Table V, which covers twenty-four years, may be regarded as an established measure of the climate, as to temperature. It will be observed that the mean temperature from June first to October thirty-first, is remarkably uniform. The descent is abrupt from November to December, and the rise commences with February, much earlier than on the Atlantic face of the continent.

TABLE I.

Showing, for each month in the year, the mean temperature at sunrise, at noon, and at ten P. M.*; the mean of extremes and the maximum, minimum, and range; the maximum at sunrise and at ten* P. M., *and the minimum at noon.*

	1873.						1874.						Year.
	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.	
Sunrise	52 35	54.71	53.47	51.65	51.60	46.16	43.20	43.39	45.19	50.63	53.03	53 10	49.87
Noon	63 03	65.32	63 97	65 81	61.03	51 68	51.03	54.71	54.39	60.77	62.97	64.97	60.72
Ten P. M.	53.68	56.35	54.67	55.61	54.67	48.71	46 03	47.68	48.84	51.90	54.51	54.37	52.25
Mean extrem's	57.69	60.01	58.72	58 73	56.32	48.92	47.11	49.05	49.79	55.70	58 00	59.03	54.94
Maximum	73.00	75.00	72.00	76.00	72 00	57.00	59.00	65.00	65.00	73.00	82.00	85.00	85.00
Minimum	50.00	52 00	52 00	44.00	45 00	32.00	30.00	38.00	33.00	45.00	50.00	50.00	30.00
Range	23.00	23.00	20 00	32.00	27.00	25.00	29.00	27.00	32.00	28.00	32.00	25.00	55.00
Max. sunrise	54 00	60.00	56.00	62.00	60,00	55.00	55.00	50.00	54.00	58.00	62,00	68 00	68.00
Max. ten P. M.	56.00	61.00	61.00	62.00	64.00	55 00	60.00	54.00	57 00	60.00	66.00	65.00	66.00
Minim'm noon.	58 00	60.00	60.00	60.00	54.00	42.00	44.00	50.00	48.00	54.00	55.00	58.00	42.00

TABLE II.

Showing the prevailing winds of each month in the year, or the amount of time, in days, during which the wind came from the several quarters of the compass.

	1873.						1874.						Year.
	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.	
N. and N. W.	0	0	0	12	12	8	21	16	10	5	2	0	84
E. and N. E.	0	0	0	0	0	3	1	0	0	1	0	0	5
S. and S. E.	1	1	3	4	5	14	6	6	6	4	3	1	53
W. and S. W.	30	30	27	15	13	6	3	6	15	20	26	29	223

TABLE III.

Showing the relative force of the wind in the forenoon, in the afternoon, and in the evening, during each month in the year. The figure 1 represents a very light current of one or two miles an hour; 2, a current of five miles; 3, of ten; 4, of fifteen; 5, of twenty; 6, of thirty; 7, of forty, etc.

	1873.						1874.						Mean.
	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.	
Morning	1.94	2 10	1.87	1.48	1.37	1.58	1.21	1.32	2 16	1.97	3.00	2.93	1 91
Afternoon	4.94	5.10	4.93	2.71	2.17	1.81	1.94	2 11	3 13	3.57	4.32	5.10	3.49
Evening	2 77	2.00	2.23	1.26	1.10	1.42	1.45	0.97	1.26	1.70	2.20	2.37	1.71
Mean	3.22	3.07	3.01	1 82	1.55	1.60	1.53	1.47	2.18	2.41	3.17	3.47	2.37

TABLE IV.

Showing, for each month and for the year, the proportion of time in which the sky was clouded, and the proportion of clear sky; the number of days completely or nearly cloudy throughout, and the number clear; the number of days in which rain fell, and the quantity, in inches.

	1873.						1874.						Year.
	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.	
Pro'n cl'dy sky.	13	14	14	9	10	16	15	9	12	10	10	6	138
Prop'n cl'r sky.	18	17	16	22	20	15	16	19	19	20	21	24	227
Whole days cl'	1	2	1	0	4	10	7	3	3	1	2	1	35
Whole days c'r	8	6	9	18	11	3	9	13	9	12	13	15	126
Days of rain	1	0	0	2	4	16	13	9	13	7	4	2	71
Quantity rain	00.01	00.00	00.00	00 32	1.20	9.50	5.25	2.48	3.50	00.80	00.64	24.48	24.48

TABLE V.

Showing the mean temperature of each month, for twenty-four years.

January	48.90	July	61.00
February	52.05	August	61.84
March	54.73	September	61.40
April	55.78	October	60.00
May	57.83	November	56.18
June	59.73	December	50.33
Mean			56.65

MAP OF THE SACRAMENTO SAN JOAQUIN & TULARE VALLEYS
EXPLANATION
MALARIAL FEVER .... 1858 '74
ISOTHERMAL LINE .... OF 60°
ISOTHERAL ,, ... OF 70°-75°
Where these Characters are spaced indicates uncertainty as to the true position of the lines
Topographical Notes.
County Boundaries
Rail Roads
Finished Canals
Surveyed Canals
Hypothetical Irrigation Canals
Swamp & Overflowed Lands
The different Hypothetical Catchment Basins are enclosed in fine hair lines and their areas in square miles are shown in Figures
PACIFIC OCEAN
COAST RANGE
SIERRA NEVADA
STATE BOUNDARY
SHASTA
TEHAMA
PLUMAS
BUTTE
COLUSA
YOLO
NAPA
LAKE
SACRAMENTO
PLACER
EL DORADO
AMADOR
ALPINE
CALAVERAS
TUOLUMNE
CONTRA COSTA
ALAMEDA
SAN JOAQUIN
STANISLAUS
MARIPOSA
MERCED
FRESNO
TULARE
KERN
LASSENS PEAK
RED BLUFF
TEHAMA
OROVILLE
DOWNIEVILLE
MARYSVILLE
NEVADA
COLUSA
LAKEPORT
LOWER LAKE
ST HELENA
CALISTOGA
WOODLAND
PLACERVILLE
SACRAMENTO
JACKSON
NAPA
FAIRFIELD
SONOMA
PETALUMA
MARTINEZ
OAKLAND
SAN FRANCISCO
STOCKTON
MODESTO
COULTERVILLE
MARIPOSA
REDWOOD
SANTA CLARA
SAN JOSE
GILROY
SANTA CRUZ
HOLLISTER
SALINAS
MONTEREY
SOLIDAD
MILLERTON
FRESNO
VISALIA
TIPTON
TULARE LAKE
INDEPENDENCE
BRIDGEPORT
MONO LAKE
LAKE TAHOE
GENOA
SILVER MT CITY
BAKERSFIELD
Buena Vista L.
Kern L.
Arroyo el Tejon
PT ST. LUIS

Malarial Fevers and Consumption in California,

(1) From report of the Board of Commissioners on the irrigation of the San Joaquin, Tulare, and Sacramento Valleys of California, eighteen hundred and seventy-four.

TABLE showing area in square miles of cachement basins.

Name of river or creek.	Cachement area.
Feather River	3,394
Kern River	2,382
American River	1,889
King River	1,853
San Joaquin River	1 631
Tuolumne River	1,514
Yuba River	1,329
Merced River	1,073
Cache Creek	1,025
Stanislaus River	971
Stony Creek	591
Cosumnes River	590
Putah Creek	584
Mokelumne River	573
Walker's Basin Creek	461
Calaveras River	390
Arroyo Los Gatos	343
Big Panoche Creek	319
Chowchilla River	304
Bear River	300
Posa Creek	278
Fresno River	258
Cantua Creek	164
Little Panoche Creek	136
Arroyo de Los Baños	125
Orestimba Creek	125
San Luis Creek	81
Arroyo del Puerto	79
Total	22,742

TABLE showing area in square miles in each county, and area of valley compared with area of mountains.

Name of county	Area of valley.	Area of mountains.	Total.
Alameda	6	74	80
Alpine	.....	508	508
Amador	.....	576	576
Butte	502	1,060	1,568
Calaveras	.....	1,037	1,039
Contra Costa	159	177	338
Colusa	1,117	1,503	2,622
El Dorado	.....	1,243	1,247
Fresno	3,270	5,560	8,836
Kern	2,798	2,642	5,440
Lake	.....	1,121	1,123
Mariposa	.....	1,418	1,411
Merced	1,312	607	1,910
Napa	.....	318	311
Nevada	.....	803	806
Placer	112	1,027	1,139
Plumas	.....	2,638	2,638
Sacramento	929	73	1,002
San Joaquin	1,271	121	1,392
Shasta	30	770	800
Sutter	530	74	604
Sierra	.....	723	723
Solano	600	186	706
Stanislaus	1,015	504	1,519
Tehama	880	2,053	2,932
Tulare	2,476	3,270	5,746
Tuolumne	.....	1,942	1,942
Yolo	653	403	1,056
Yuba	162	482	644
Total	17,822	32,916	50,658

monious cooperation; to cause mind to bear on mind; to work out the problem of climatic and topographical influences on the physical con-

dition of the people of this State; to determine the best methods of holding life and health in integrity; and to remedy the evils incident to existence. These I conceive to be its prominent aims. Relying, therefore, upon that professional spirit for which this society has ever been distinguished, and which has already gained for it a name and a place among the scientific institutions of our country, I will proceed to the discussion of those special subjects on which I more particularly desire to have the benefit of your experience and knowledge. And now let me direct your attention to the subject of—

MALARIAL FEVERS AND CONSUMPTION IN CALIFORNIA.

If any fact has been well established by the sickness and mortality statistics of the State Board of Health, it is that malarial fevers and consumption constitute the most prevalent forms of disease—the latter being the most aggravated cause of death in California.

Let us look into this statement seriatim, and if we cannot pierce the misty vail, which obscures the etiology of these diseases, we may yet be enabled, through our united experience, to suggest, at least, some means of controlling, if not of preventing their prevalency and fatality.

MALARIAL FEVERS.

The vital statistics of the last United States decennial census confirm what has just been stated as the result of the investigations of the State Board of Health, viz: that the whole State is more or less subjected to malarial fevers. Under the general term "typho-malarial," I have included in the mortality statistics all the varying forms of these fevers supposed to be dependent on one and the same poison—the different grades, described by medical writers, from the simple intermittent to the continued and pernicious, bearing a pretty direct ratio to the intensity of the poison.

According to the former authority the maximum mortality by these fevers is found to occur in Sacramento, Amador, El Dorado, and Placer Counties, and also, in the northern part of the Sacramento Valley, and all the northeast corner of the State—the rate of mortality being from five and one half to nine per cent of all causes of death. This closely coincides with the data published in the second biennial report of the State Board of Health, which shows a somewhat greater mortality in Marysville, where it is fifteen per cent, and in Placerville, where it is the same; and also in Colusa and surroundings, where it is about twelve per cent. A lesser rate of mortality, from two and one half to five and one half per cent is found, according to both these authorities, in Marin, Solano, Napa, Yolo, Nevada, and Sierra Counties, in the mountains, the lower part of the San Joaquin Valley, and the region about the Bay of San Francisco—the peninsula itself of San Francisco enjoying an almost entire immunity.

NATURE AND CAUSES OF MALARIAL POISON.

Up to this time but little is known, according to the latest authority (1), of the nature of malarial poison. The older observers (Mascati,

(1) Ziemssen Cyclopædia, vol. 2, 1875.

Vauequelin, Fontanelle), merely demonstrated the presence of decomposing organic matter in marsh-exhalations, and the theory has long been generally accepted that malarial poison is exclusively the result, in gaseous form, of the decomposition of vegetable organisms, such as carbonic acid gas, carbureted hydrogen, and according to Schwalbe, carbonic oxysulphide.

But although no analysis of the air has yet disclosed any immediate principle to which the unhealthy influence of malaria or marsh-miasm may be ascribed, still, if we admit its existence as the efficient cause of the disease in question, it is easy to see why the rates of mortality by these fevers in California, thus determined by positive statistics, are just in the proportion in which they are found in certain parts of the State. A rich alluvial soil, abundant vegetation, rivers and creeks whose banks are subject to overflow, and inundations of vast prairie lands, which every year occur to a greater or less extent—these conditions, conjoined with a high Summer temperature, together with sudden and sharp transitions from the heat of mid-day to chilling nights, are the well recognized hypothetical factors concerned in the production of malaria; and it is precisely in those regions where the greatest mortality and sickness, caused by malarial diseases, as just seen, happens, that the concurrence of all the conditions, just enumerated, is met with in the fullest degree. Of all the elements which enter into the sum of these conditions, water seems to play the most active part.

Geographical facts, collected by medical writers from Hippocrates downwards, show that every country is unhealthy in proportion to the quantity of undrained alluvial soil it contains; the inhabitants of such districts dying often in the ratio of one in twenty, instead of one in thirty-eight—the average mortality in healthy countries. Ancient Rome was once the seat of so many fatal epidemics that the Romans erected a temple to the goddess Febris. Those epidemics were known to arise from the great masses of water, poured down from the Palatine, Aventine, and Tarpein hills, becoming stagnant in the plains below, and converting them into swamps and marshes. The elder Tarquin ordered them to be drained, and led their waters by means of sewers to the Tiber. These subterranean conduits ramified in every direction under the city, and this system of drainage, which was continued as late as the Cæsars, rendered Rome proportionably healthy, and the seat of a larger population than has since, perhaps, been collected within the walls of any city. On the invasion of the Goths and Vandals, however, the public buildings were destroyed, the embankments of the Tiber broken down, the aqueducts laid in ruins, the sewers obstructed and filled up, and, the whole country being now again overflowed, Rome once more became the seat of an almost annual paludal fever, as in the times of her earliest foundation.

Referring to the numerous facts of a similar nature bearing upon the etiology of fevers, and which are to be found in the works of Lancisi, Baglivi, Rigault de L'Isle, Maccullock, Furguson, Rush, and a host of writers, I would here remark that it appears, from an extensive investigation of the subject, several years ago, by the English General Board of Health, the conclusion was arrived at that wherever water is laid on the land in greater quantities than it can immediately or very soon absorb, or wherever there is alternate wetting and drying, the effects of malaria, if other conditions be favorable, are sure to be manifested. Instances upon instances have been brought forward, not only from England, but from other countries where irrigation is practiced, of the

appearance and disappearance of fevers coincident with the operations of flooding and drying particular tracts of land. In the Lombardo-Venetian provinces, where there is some of the oldest, most extensive, and skillfully conducted irrigation in Europe, the Government long ago found it necessary to interfere for the protection of the health of towns. By law, as stated on positive information received by the same high source, just referred to, from the authorities at Milan, "permanent" irrigations are prohibited within five miles distance of towns. This range, that has been assigned by experience and predicated upon the most carefully observed facts, to the influence of malaria so far beyond its source or origin, taken in connection with the numerous instances, resting upon the most respectable authorities, of the febrile cause being borne in the common atmosphere, as, for instance, from Holland to England—of ships receiving the infection at a great distance from land—together with the collateral evidence afforded in Europe, from the frontiers of Asia to the other extremity of that continent, and particularly in Italy, that as the western coast presents a larger surface of infections, so malarial fevers prevail more extensively under the influence of southwest winds than of the opposite currents. All these corroborating circumstances not only tend to render it highly probable that the noxious agent must be a product of vegetable decomposition changed from a fixed to an æriform state, and evolved in the lower regions of the atmosphere, and to place the question of the morbific effect, at a distance, of winds passing over pestiferous localities almost beyond the possibility of a doubt, but also satisfactorily account for the wide diffusion of malarial fevers throughout the length and breadth of this State (1)—disseminated from the generating foci, the watercourses, sloughs, reservoirs, etc., in all directions, just as they happen to be located.

Indeed, if facts were wanting to establish the point in all the hypotheses which have been framed, concerning the etiology of these fevers, that moisture, at a given temperature, is one of the essential elements in the production of its remote causes, and that these causes can be wafted to great distances from their sources, the medical history of our State abundantly supplies.

MEDICAL HISTORY, ETC.

In reproducing, therefore, in part, for the benefit of the public, for whom the publications of the State Board of Health are prepared, what was advanced by me in eighteen hundred and sixty-five, in my report to the American Medical Association, I will hear repeat that, prior to the Fall of eighteen hundred and fifty-eight, when autumnal fever prevailed so extensively, the plains, as well as the mountains of California, were proverbial for their salubrity. With the exception of the irregular development of confused forms of fever in towns and isolated localities, chiefly where stagnant water existed, and of intermittents in the neighborhood of exposed river-courses and low places, which are inundated

(1) Lancisi was among the early writers, already referred to, who recognized the agency of the wind in aiding the spread of malarial fevers by virtue of its power of carrying material disease-germs. He attributes to the influence of the winds the fact that the Roman Campagna became more unwholesome after the removal of the sacred groves, and its consequent greater exposure to the miasm of the Pontine marshes. Similar testimony may be found in all ages, and of the most varied kind.

during certain portions of the year, endemic diseases were comparatively unknown—at least after the introduction of the comforts and ameliorations of civilized life, and when men ceased to overtask and expose themselves in the reckless manner peculiar to the earlier immigrants. But how stands the case now? An extensive system of irrigation has been inaugurated in the Tulare, San Joaquin, and Sacramento Valleys for agricultural purposes, which, unless the contemplated drainage be carried out in the most thorough manner, in accordance with the precautionary suggestions of the Board of Government Commissioners, will render our wheat fields no mean rivals, in unhealthfulness, of the notoriously miasmatic rice fields of our Southern States.

For mining purposes, canals, thousands of miles in aggregate length, have already been dug in all directions, without a thought as to alignment or drainage, to lead the water in innumerable serpentine courses from the rivers into the placers, towns, and settlements, and nearly every valley that can be dammed on the line of these ditches has been appropriated as reservoirs to hold water. The action of an almost tropical sun upon the decaying vegetable matter that remains in these canals and reservoirs, especially around their margins, has been manifested in its effects. Not only in the plains and agricultural regions, but along the whole range of the foothills, from Shasta to Merced, as indicated in the accompanying map, malarial fevers prevail more or less every Fall. In eighteen hundred and fifty-eight, so universal was the endemic that it might have been properly termed an epidemic. At Folsom and in the neighboring country, previously regarded as particularly free from miasmatic diseases, scarcely a miner escaped. In Placer the effects were most alarming, not in fatality, but in extent. The following paragraph from the *Placer Press*, published in Auburn, gives a concise explanation of the circumstance:

"Almost everybody living west from Gold Hill is either down with fever, or chills and fever, or more or less affected by the miasmatic poison generated and floating around in that locality. The cause of this unusual sickness is generally chargeable to the reservoirs of the several ditches. They are filled with sedimentary water, which spreads over a large plain during the day, exposing a great surface of wet vegetable matter to the sun, as the water is drawn down. This is a most unfortunate fact, as without reservoirs the county cannot be mined, and sickness destroys the ability to labor. What can be done to remedy the evil?"

To show further that I am not drawing upon imagination to make out a case of deep and pervading interest, but stating actual facts, patent and accessible to every one, I will here cite a few other statements from the newspapers of that period, as affording the best historical record of past events:

The *Citizen*, published at Monte Christo, after noticing the extraordinary fact, clearly indicating a pestilential constitution of the atmosphere, of an almost universal tendency of every bruise, cut, applications for neuralgia and rheumatism, such as blisters, etc., to result in the formation of abscesses, alludes, likewise, to the "general prevalence of sickness."

The *Butte Record*, of Oroville, at the same time, stated: "The work on the deep shaft has been suspended, in consequence of illness among the company that has it in charge. A great deal of sickness exists among the bluff miners, more than any previous year." About the

same period the following card, addressed by the citizens of Oroville to the editor, appeared:

"The undersigned, citizens of the Town of Oroville, having witnessed with deep regret, during the past month, the sickness which (heretofore unknown to us) is this Fall afflicting nine tenths of our people, injuring business, and which now threatens to impede the future growth and prosperity of our town, (1) would respectfully suggest that, as it is now a conceded fact that our sickness is the result of inhaling the miasma arising from the stagnant waters to the south and west of the city, a meeting be called at the Court House, on Tuesday evening, October nineteenth, at seven o'clock P. M., for the purpose of taking steps to remove the nuisance."

The same paper has the following remarks:

"The successful working of the river claims demands a longer season of dry weather; the health of the country seems to require rain. Health is of vastly more consequence than the accumulation of gold, and we pray for rain even at the expense of the river miners. * * * Accounts from other sections of the State show that this region is not the only one infected. Similar complaints to those experienced here prevail along the Yuba and in many of the mining and agricultural districts of the foothills."

Unfortunately for the future welfare and prosperity of this town, the unusual occurrence of the most copious rains ever experienced in October, followed by heavy frosts, obviated for the time being the necessity of the active steps called for, and nothing has since been attempted, either in that locality or elsewhere, to prevent a repetition of the same calamities. The conditions favorable to the evolvement of the febrile poison, although interrupted at that time by the change of season, remain not only the same but are renewed every year, over a wider field, with more or less potency.(2) In fact, in no other country or epoch in the world's history than in California at the present time has man's action ever been known to change so rapidly or so permanently the face of nature. Millions of tons of soil are washed down annually through the Sacramento and American Rivers and their tributaries. Each ton of soil so transposed by the hydraulic ram not only incapacitates a certain area of high land for the growth of timber and other vegetation but also tends to raise the river bottoms. And although the terrible effects of outraged nature which the history of analagous civilizations and circumstances teaches have not yet manifested themselves strongly enough to arrest general attention, still it is only a question of time when, by the denudation of our mountain slopes of their forest growth, a more rapid melting of their snow must follow, and consequently increased frequency and violence of freshets and coincident floodings of the low lands. Unless, therefore, some effort is made towards correcting and providing against the evils resulting, in a sanitary point of view, from the present and prospective modes of spreading water over the surface, the most valuable portion of California will become more and more obnoxious to the health of the inhabitants during the autumnal months. It is due, therefore, to the State, with whose general prosperity and welfare our own interests are identified, and

(1) The soundness of these predictions have been confirmed by time.

(2) See the account of the late epidemic, in this report, among the Chinese on the Feather River, near Oroville.

especially is it due to the science we cultivate, that the sanitary bearings of this subject should be investigated in a philosophical manner, especially by the State Board of Health and the members of this society, most of whom have been living in the midst of the malarial region for nearly a quarter of a century. We can all speak of these diseases from direct practical experience; and taking it for granted that every one admits of the existence of its cause in the atmosphere, I trust that, by thus directing attention to the conditions already stated to be connected with its evolvement, to elicit your opinions, either to confirm or invalidate whatever I may further advance. In this manner I may be enabled to diffuse, through the reports of the State Board of Health, some sound practical knowledge on a subject of deep import, as well to the science of medicine as to that of political economy.

The question which naturally suggests itself here is: If water has the agency attributed to it in the production of the toxical effects under consideration, what are the concurrent circumstances necessary to give it potency or efficiency?

MEDICAL TOPOGRAPHY AND HYDROGRAPHY

supply many facts which go to show that though malarial fever prevails perpetually and virulently within the tropics, there are still places having the same temperature, but varying in other conditions, that are never affected by it. The Summer heat of our southern desert is intense, but those who traverse it and keep at a distance from its watercourses remain perfectly healthy.

Everywhere west of the States of Arkansas, Missouri, and Iowa, surface water is scarce, the declivity of the plain, which stretches from the Rocky Mountains, favoring its escape, while the subjacent sand absorbs even considerable rivers. Thus, as we advance into the desert, we come at the same time to the limits of surface water and malarial fever. That the heat here is sufficient to engender malaria, if that was the only necessary condition, is proved from the fact, that far to the north of this region, where the whole country is essentially lacustrine, the fever prevails. Thus the shores of Lake Ontario and Erie, with those of the southern extremity of Huron and Michigan, are infested, and suffer far more than the drier lands which surround them. Beyond those limits, on the shores of the two latter lakes, and on those of Lake Superior, the fever is never epidemic, although water is abundant. Still further north, where small lakes and their connecting streams exist in countless numbers, the disease is unknown, while under precisely the same conditions in Florida, Alabama, Mississippi, Louisiana, Texas, Illinois, Tennessee, Kentucky, Indiana, Ohio, and other States, it never fails to show itself in Autumn. These facts show that water and a certain degree of heat are essential to the production of the disease. From the diligent study of these hypothetical causes, and their comparison with other instructive facts furnished by our army statistics, the late Dr. Daniel Drake inferred that a mean annual temperature of sixty degrees is necessary for the production of the fever, and that it will not prevail, as an epidemic, where the temperature of the season falls below sixty-five degrees. The following is an abstract of some of the conclusions, as to the modus operandi of these agents, arrived at by the same high authority just quoted:

"Surface water not only contributes largely to the production of a luxurious vegetation destined annually to perish, but is indispensable to

the decomposition of what it has aided in producing. Hence, without the agency of water and heat, none of the deleterious gases, which are supposed to be thus generated, could have an existence.

"But the presence of water in any or all quantities will not answer equally well. If there be too little, the molecular movements of fermentation are arrested for want of a solvent; if too much, the atmosphere, indispensable to the process, is excluded, or the evolved gases are absolved and retained.

"The combined agency of moisture and heat not only facilitate the multiplication of minute but visible animals and cryptogamic plants, but also may be presumed to multiply the microscopic, both animal and vegetable.

"Under the influence of solar heat, water impregnates the air with vapor, giving a high dew point; and, other circumstances being equal, the evaporation is greatest where the heat is highest."

Adopting these conditions, which are based upon the position already assumed by me, of the existence of a specific ærial poison as the cause of malarial fever, I pass on to show that another essential condition, viz: a Summer temperature of sixty-five degrees is to be found also in California, sustaining the same correlation with water or moisture here as has been observed elsewhere in the production of the morbific agent.

The results of meteorological observations made during the last twenty-two years at Sacramento and other points, establish the fact that the climate of the immense Sacramento, San Joaquin, and Tulare Valleys, which the Commissioners of Irrigation very properly call the "Great Valley of California," appears to vary as little as its geographical formation. It is true that the Winters are severer in the higher and more elevated portions, but this is counterbalanced by a considerable increase of Summer heat, which makes the annual average of temperature the same. Thus it will be seen, on the accompanying map, that the isothermal line of 60° reaches from Millerton, latitude 37°, to further north than Redding, even to Shasta, latitude 40° 35′. It is also seen that the isotheral line of 70°–75° traverses the same direction, and even goes further north than Redding. Indeed, the Summer heat of the elevated portions of the valley is often intense, reaching at times not unfrequently to 110°. At Coloma I have seen the thermometer read as high as 107°, when as well protected as could be against either reflected or radiated heat, and I have good reason to believe that high up in the foothills the heat is more intense than in the lower part of the valley.

The general simultaneous rise of the rivers, which water this whole region, seem to show that their supplies are affected by the same climatic influences, not only in respect to the precipitation of rain, but also the melting of the snow at their sources. Hence it is seen that so far as heat and moisture are concerned in the production of malaria, these elements exist in the elevated, as well as in the lower parts of the entire valley.

It is probably owing, in a great measure, to the great excess of temperature, that malignant or congestive forms of fever are sometimes met with in the elevated northwestern part of the State. But it must be remembered that, just as it happens on the summits of other rocky countries, as Gibralter and the Ionian Islands for instance, where severe malarial fevers prevail, here also springs arise. The slightest frost produces fissures into which mould and vegetable matters insinuate themselves, while the bare rock becomes heated to an intense degree. The intense heat of the sun, likewise, acting just as the frost, may cause

cracks and deep rifts in the earth, which might give free exit to the miasm from beneath. Whether similar conditions will be found to exist, explaining the origin of "mountain fever," is not yet determined. Humboldt, on ascending the Orinoco, found the station at the great fall depopulated by fever, which the natives attributed to the bare rocks of the rapids. He determined the heat of these rocks to be 118.4° Fahr., while the temperature of the air immediately around was only 78.8° Fahr. Again, the rock of Gibralter is known to be percolated with water, so that we can hardly conceive of a more pestilential focus of disease, when the chemical causes necessary to the formation of miasm are combined. The existence of paludal fevers in the dry and rocky districts of our State, therefore, although it may appear extraordinary and unexpected, is not necessarily an exception to the general laws of such diseases being generated by miasmata, the result of vegetable decomposition. For if heat and moisture were sufficient to account, *per se*, for the occurrence of these fevers, we would find them prevailing out at sea, in all the temperate and tropical latitudes, among seamen. But this does not happen, whatever may be the temperature under which they cruise. It is when they approach the coast, or land upon it, that seamen are attacked. It may also be here remarked, that in places occasionally subject to the disease in various grades of intensity, sickly seasons are not necessarily characterized by a higher dew-point than the corresponding periods of other years in which the disease does not prevail to any extent. We may, therefore, safely adopt a further conclusion of the same authority just quoted, that, besides heat and moisture, there is another obvious condition, which is necessary to the production of malarial fevers, viz: dead organic matter resting on, or blended with the mineral elements of the soil.

Although the evidence regarding the geological nature of soil as a cause of fever is somewhat conflicting, still it is a fact that the usual localities, in which malarial fevers abound, are those in which the soil consists of mineral, vegetable, and animal matters, mixed together, in such proportions and of such constituents chemically as tend to absorb moisture and retain it, and subsequently to decompose. Such soils are known as *alluvial;* and that these constituents exist in our great valley to a considerable extent, and under circumstances favorable for the engendering of the morbific effect, will readily appear in the following

GEOLOGICAL AND TOPOGRAPHICAL SKETCH.

The area which has received the name of the "Great Valley of California," and which constitutes one of the five divisions of Central California, as laid down by Professor Whitney, lies inclosed between the separated, but inosculating, ranges of the Coast Mountains on the west, and the Sierra Nevada on the east, both having the same common trend. The Coast Mountains form a belt thirty to forty, and even fifty, miles wide, composed of several associated ranges, and having an altitude of from three thousand to eight thousand feet. The highest point in sight from San Francisco is Mount Hamilton, about fifteen miles east from San José. This is four thousand four hundred and forty feet high, or just ten thousand feet less than Mount Shasta. Monte Diablo, although five hundred and eighty-four feet lower, is a much more conspicuous object. North and south of the central portion, the coast

ranges rise higher as they approach the Sierra in each direction, and the highest points attain as much as eight thousand feet. The coast ranges are composed, for the most part, of volcanic rocks, trap, trachyte, and pumice, with occasional protrusions of granite and serpentine. Their flanks, on either side, are interruptedly occupied by tertiary sandstones, and by volcanic marls and tufas of still more recent date—the sandstones containing characteristic miocene fossils; the finer marls containing infusoria, generally of fresh water origin. What gives its peculiar character to the Coast Range, according to Professor Whitney, is the delicate carving of their masses by the aqueous erosion of the soft material of which they are composed. In early Spring the slopes are of the most vivid green; Spring, here, commencing with the end of Summer. Winter there is none. Summer, blazing Summer, tempered by the ocean fogs and breezes, is followed by a long six months Spring, which, in its turn, passes almost instantaneously away at the approach of another Summer. As soon as the dry season sets in, the herbage withers under the sun's desiccating rays, and the slopes remain bare for six months in the year.

The Sierra Nevada Range, so called from the perpetual snow on its summits, owes its origin probably to the same general system of elevation and nearly the same date as the Coast Mountains—*i. e.*, subsequent to the deposition of some of the tertiary strata. The great mass is composed of plutonic or volcanic rock, granite, gneiss, mica-schists, and porphyries, trap, trachyte, etc., with auriferous talcose slates and veins of quartz. These strata having been extensively broken up and eroded by aqueous or glacial action, have, in the rearrangement of their constituent materials, given rise to the *placer* deposits which skirt the base of the range. A metamorphic limestone is found at intervals skirting the great valley, highly crystalline and containing no fossils. The surface of the plain between the ranges is underlaid by beds of transported material—gravel, clay, and tufaceous conglomerate—several hundred feet in thickness, which were once deposited as sediments on the bottom of the trough, but have been extensively rearranged by the present watercourses, and in many places subjected to considerable disturbance from volcanic action. Considering the Sierra to terminate on the north at Lassen's Peak, its length will be, according to Professor Whitney, about four hundred and fifty miles, and its breadth, taking the valleys of Walkers, Mono, and Honey Lakes as its eastern and the base of the foothills as its western limit, may be set down as averaging eighty miles. This width, however, is very unequally distributed between the two slopes; the western is much the most gradual, being nearly to the level of the sea; while the eastern is to the level of the Great Basin, some four thousand feet above tidewater. The western slope of the Sierra rises, in the central portion of the State, opposite Sacramento, at the average rate of about one hundred feet to a mile, the elevation of the passes being about seven thousand feet. From latitude 36° 32′ to 39° 45′ the dominating peaks sink from fifteen thousand to eight thousand four hundred feet, and the passes from twelve thousand to five thousand four hundred feet.

The climate of the Sierra Nevada varies, of course, with the altitude. The traveler, leaving San Francisco, will have to rise several thousand feet, on the flanks of these mountains, before he will come to a region where the mean temperature of Summer is as low as that city. As high up as eight thousand feet or ten thousand feet the days are quite comfortably warm. "On the very highest peaks, at elevations of

twelve thousand feet or thirteen thousand feet, we rarely," says Prof. Whitney, "felt the want of an overcoat at midday. An examination of our thermometrical observations shows that we had the mercury almost always over 80° in the Yosemite Valley, at an elevation of four thousand feet above the sea, during the six midday hours in June and July, although the nights were, almost without exception, cool enough to make a pair of heavy blankets desirable. * * * At the summit of Mount Dana, thirteen thousand two hundred and twenty-seven feet high, the temperature marked at noon was 43°; and on Red Mountain, at an elevation of twelve thousand feet, the thermometer stood at 58°." The high mountains of California receive, probably, their whole precipitation of moisture in the form of snow; and of this an enormous amount falls during the Winter months exclusively. It is the melting of this, in Summer, which keeps the streams full of water high up in the mountains, and these, in turn, furnish the canals or ditches which convey the indispensable supply for mining and agricultural purposes. These ditches are deep in proportion to their width, and have a rapid fall, so as to lessen the evaporation which so rapidly diminishes the quantity of water in the streams flowing naturally down the Sierra. From the summits of the higher peaks the snow seems to disappear by evaporation, rather than by actual melting. On the top of Mount Shasta, for instance, there is no indication of dampness. "Pieces of paper," says Prof. Whitney, "with the names of visitors written on them and laid in uncorked bottles, or on the rocks themselves, were found by us to have remained for years as fresh and free from mould or discoloration as when first left there." It is this peculiar dryness of the atmosphere which renders the mountain climate of California so beneficial in certain cases of consumption; and it is from this consideration that I have devoted so much space to the topography of this region.

Among these lofty ranges the inhabitants of the Mississippi Valley may seek refuge from the heated moisture of their debilitating Summer months; while the invalid from the eastern slope will exchange the chilling, damp east wind for the invigorating mountain breeze, and thus obtain a new lease of life. One of the greatest drawbacks from the benefits of traveling in the Swiss Alps, is the uncertainty of the weather and dampness of the climate. But here, at high altitudes, all through our California Alps, the weather during the Summer is almost always the finest possible for camping out, and for securing the advantages of *open-air* treatment.

Between the mountain walls just described, lies the great valley, as a broad plain, the central portion of which is scarcely raised above the level of the sea, while the remote ends are not more than twice as many feet above as they are miles distant from the center. The greater part of the fall of the draining streams being confined to the vicinity of the ends of the valley, as a consequence, through most of the length the current of these streams is slow, their course tortuous, and their borders, especially near their point of exit, are marshy, and covered with wide expanses of *tulé* (bulrush). The center of the valley is alluvium, with little diversity of level. The agricultural capabilities of the different parts of this valley, though influenced by the structure and constituents of the soil, which is generally fertile, but sometimes coarse and gravelly, or stony and barren, are, as is well known, more directly dependent on the degree in which its greatest want—the want of water—is supplied. With an abundance of this indispensable element, it would be one of the most productive portions of the globe. But if this want

is supplied by the system of irrigation which has already been inaugurated, it will inevitably become one of the most insalubrious. This question now recurs, what can be done, while reclaiming and fertilizing this immense agricultural region, to preserve the health of the inhabitants?

RELATIONS OF MEDICAL TOPOGRAPHY WITH MALARIAL FEVERS IN THE SACRAMENTO VALLEY.

Resuming the study of medical topography with reference to malarial fever in the great Mississippi Valley, I find, according to Dr. Drake, that it is a safe generalization to conclude that, all other circumstances being equal, fever prevails most where the amount of organic matter is greatest, and least where it is least. In valleys where it is washed down from the hills and deposited with the débris of rocks, this substance rapidly augments itself by promoting more luxurious crops of vegetation. Whereas, in the pine lands of our Southern Atlantic States, it is small in quantity from the sandiness of the surface, just as it is in our desert lands, where the fever is unknown.

Now, with respect to the Sacramento Valley, the amount of organic matter is found very different in different parts, for its production depends on the fertility of the soil, on temperature and moisture. Where these elements are all present, as in the neighborhood of our rivers, sloughs, and overflowed lands, and their agency is not counteracted by a growth of tulé or other vegetation, there we always find more or less of fever every year; indeed, it is an endemic of such localities. Especially do we find the disease most constant along those river courses whose turbid waters, being confined in the dry season within narrow bounds, leave a great part of their channels uncovered, and thus expose an immense amount of deposit brought down from the washings of the auriferous soil—as the Yuba, the Feather, and the American Rivers, and their tributaries. There are, however, regions of our valley where the loose upper stratum consists chiefly of the débris of rocks beneath, or of the deposits of the débris of other rocks spread over the surface by ancient inundations, and likewise tracts in which the rocks themselves appear at the surface. Here, owing to the rolling character of the surface, and the general declivity of the land, the organic matters are washed off by the rains of Winter into the innumerable ravines and channels of creeks and rivers with which the face of the country is diversified, and which, becoming dried up in Summer, the whole region has remained perfectly healthy. Since, however, the introduction of water for mining and agricultural purposes—the digging of ditches, the building of dams, and the establishment of large reservoirs—we find these very regions subjected to the disease; and this, too, we find to be in perfect accordance with all that has been observed in every part of the globe, where intermittents prevail. For it appears necessary to the production of the efficient cause, be it malaria, or whatever we please to term it, that there should be a surface capable of absorbing moisture, and this surface should be flooded and soaked with water, and then dried; and the higher the temperature, and the quicker the drying process, the more powerful—more powerful probably because more plentiful—is the effect. Hence the conclusion is legitimate, that decaying organic matter brought and deposited in various directions, in a condition and under circumstances most favorable to decomposition, has been instrumental in occasioning malarial fever in California. As to the mode in which this decaying organic matter coöperates with the other essen-

tially necessary conditions, heat and moisture, in the production of the morbific effect, we have no positive knowledge, nor would the discussion of the various hypotheses that have been framed in relation thereto, inure to any practical good. It may supply the material out of which a poisonous gas is formed, as maintained by some, or it may prove a nidus or hotbed for animalcules or vegetable germs, (1) according to the theories of others. Some, I must here take occasion to remark, attribute the poison to subterranean exhalations, to the gaseous effluvia from a volcanic soil. Still others deny any specific cause, or, again, believe it to consist in an accumulation or modification of the electricity of the earth and the air, although none of these views have been as yet established by sufficient proof; still we know the conditions that are necessary to give efficiency to the toxic agent, from whatever source it may be derived. As long as these conditions co-exist, certain effects are produced—interrupt, counteract their co-efficiency—and the probability is we may rid ourselves, to a great degree, of the annual recurrence of malarial fevers.

MODIFYING AND AMELIORATING CIRCUMSTANCES.

From the foregoing cursory examination of the conditions under which malarial fever has been developed in California, I hasten on to a further consideration of some of the circumstances and peculiarities attendant on its appearance here, and which have also been found by experience everywhere capable of controlling its evolvement or production.

Cities and large towns, it is well known, seldom suffer from malarial fever, and are to be considered as in some degree presenting opposite conditions to a sparsely settled country. As the buildings extend out, and the closely inhabited portions expand, and by so doing lessen the area of humid and exposed soil, the disease recedes. The medical history of New York, Buffalo, Auburn, Syracuse, Philadelphia, Charleston, Savannah, Louisville, etc., illustrates this. The statements of

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(1) This theory, says Dr. H. Von Ziemssen (Cyclop. Prac. Med., Vol. II, p. 585), has been brought forward again, of late, by various observers. *Thomas* (Archiv f. Heilkunde, VIII, p. 225). *Scoda* (Clinique Européenne, 1859, Canst. Jahresber, 1859, IV, p. 73), believes them to be either living or in a state of decomposition. *Baxa* (Wien. Med. Wochenschr, 1866, p. 78), saw low, cell-like structures in drinking water. *Balestra* (Compt. rend., LXXI, No. 3, p. 235), discovered a species of algæ in the Pontine marshes. *Salisbury* (Amer. Journ. Med. Sc., 1866, Jan., p. 51), found in his investigations in the valleys of the Ohio and Mississippi, that the sputa of the sick contained small elongated cells, presenting themselves singly or in rows, which he considered to be algæ-cells of the species palmella. These he also found and collected on glass plates set up over marshy ground, and in great quantities on the clods of an upturned marshy ground. According to his observation, these algæ-cells do not rise over one hundred feet above the level of the sea. He was able to produce the most intense attacks of intermittent fever by means of the fresh clods, if allowed to place them within the open window of a sleeping room in a house lying about three hundred feet high. The attacks, in four persons, the subjects of two experiments, followed in ten, twelve, and fourteen days, and were broken up by quinine. *Hannon* (Journ. de Med. de Bruxelles, 1866, Mar., p. 497), says that when he was devoting himself to the study of the sweet water algæ, during their fructification, he was attacked with an intermittent fever of six weeks duration. In opposition to Salisbury, *Harkness*, of Sacramento, states (Boston Med. and Surg. Journal, 1869, Jan. 14th), that he has found the palmella spores in the snow, and at the summit of the highest of the California Alps, and claims that they may very readily become mixed with the saliva and the urine from without—at the same time having nothing at all to do with malaria. Nevertheless, Ziemssen states that, on the Tuscan Appenines, fevers are to be found at the height of one thousand one hundred feet; on the Pyrenees, at five thousand feet: on the island of Ceylon, at six thousand five hundred feet; and in Peru, at ten thousand feet, and even eleven thousand feet.

Professor Yandell, relative to the last named city, are so apposite that we cannot refrain from quoting them in confirmation of our remarks.

"The rock, of which the subsoil is composed, forms a surface remarkable for its evenness; and the soil which it produces, as it crumbles under the action of the air, frost, and water, is peculiarly retentive of moisture. Ponds and slushes are abundant wherever the black slate constitutes the surface rock. The first houses erected at the fall, were built in the midst of ponds. Louisville, while it stood amid its ponds, was regarded as one of the most sickly towns in the Valley of the Mississippi. It was commonly called the 'graveyard of the west.' Intermittent fever was a regular annual visitant, and occasionally a form of bilious fever prevailed, rivaling yellow in malignity, and threatening to depopulate the town. The ponds have all disappeared—the streets have generally been paved, and though the grading is defective, and can never be as effectual for drainage as it might be rendered on a less even surface, still it is such as to carry off the rains into the river and the ditches south of the city. The only parts of Louisville (now) obnoxious to the charge of unhealthfulness, are its suburbs."

Now, with regard to Sacramento, whatever of reason there may be in the opinion formerly advanced by me, that the so-called cholera of eighteen hundred and fifty-two, when the city was in a transition-stage between country and a filthy, ill-conditioned town, traversed in all directions by sluggish, stagnant sloughs, was nothing more than a highly malignant form of malarial fever, there certainly, since a better order of things obtains, has not been witnessed, to the best of my knowledge, a single case of malignant fever within the city proper. All of the cases since met with here, have been of the simple intermittent variety, originating in the suburbs, and especially in that portion bordering on the American River, (1) where the amount of deposit is enormous.

That this modification, or mitigation, of the grave forms of malarial fever formerly met with is attributable, in a great measure, to the agency of similar sanitary measures to those just alluded to, respecting Louisville and other cities, will, I think, not be questioned by any one at all acquainted with the relative condition of the city then and now. In addition to the raising of the streets with sand above high-water mark, the better draining of the city, the filling up and damming of the sloughs against the ingress of water from the river, and the extensive building of houses, which intercept the action of the sun in low parts,

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(1) Some idea may be formed of the immense amount of deposit brought down from the washings of the auriferous soil, above alluded to, when I state that on my arrival in Sacramento, in eighteen hundred and fifty, a large brig, named La Grange, was anchored in the middle of the mouth of the American River, to serve the purpose of a prison. Where that brig was anchored, there is now a road; what was then the mouth of the American River being completely filled up.

We are not aware that a sectional area-admeasurement of the Sacramento River has ever been made, but estimating the amount of water which passes down the river each second, during freshets, at three hundred and twenty-seven thousand six hundred cubic feet, we find, on an average, that there are carried in suspension past Sacramento City (a certain portion being deposited, as is shown by the elevation of the low as well as the high water marks on the rain gauge) thirty-eight thousand seven hundred and seventeen tons every hour, more or less, according to the stage of the American River—this affluent, owing to mining operations, being always most charged with detritus. The solid material, thus ascertained to be suspended in the water, is found on calculation to be sufficient to cover, in one year, a square mile, to the depth of two hundred and fifty-six feet. With these facts before us, it would seem that, if ever the ætiology of epidemics and endemics is to be solved by the present methods of topographical and meteorological research, the Sacramento River, with its tributaries and influences, must be paramount in unraveling the enigma of the diseases of its basin.

there has been a very general cultivation of shrubbery, and plantation of shade and fruit trees in the streets and gardens. From what has been observed respecting the protective power of trees and forests against malarious diseases, it cannot be doubted that this extensive arboriculture has exercised a powerfully controlling influence.

Besides shielding, from the solar rays, the humid surface of the earth, trees have been supposed, from the time of Pliny, to absorb insalubrious exhalations. Their beneficial effects are, we think, to be accounted for in this way more reasonably than by the obstacle or mere physical obstruction they offer, like a fence or wall, as conjectured by Lancisi and others. "This opinion," says Dr. R. La Roche, in his erudite treatise, controverting the supposed connection of pneumonia with autumnal fever, "this opinion has, to a certain extent, received the sanction of Thouvenelle, Copland, and other modern writers; and its correctness is rendered probable by the results of certain experiments made long ago, and repeated more recently to ascertain the fact." "Plants," says Julia de Fontenelle, "which Priestley had inclosed in glass jars filled with vitiated air, continued to thrive, and, at the end of a few days, this air had become as pure as that of the surrounding atmosphere." Dr. Lewis, of Mobile, adverting to the subject, remarks: "It is the generally received opinion, that living vegetation protects the human system from the deleterious effects of malaria; and reasoning by analogy, it would appear that experiments, made by scientific men, have satisfactorily explained the mutual dependence of the animal and vegetable kingdoms on each other for support. It has been ascertained that if air, rendered pernicious by respiration, be confined in a bottle into which some green plant has been introduced, and exposed to the action of the sun, the carbonic acid will be absorbed and the air restored to its original condition. The putrefaction of animal matter, and the decomposition of vegetable substances, would cause a sufficiency of carbonic acid vapor, when united with atmospheric air, to destroy every living being, were it not for this wise provision of nature. This gas, which is poisonous to the human as well as animal species, is a source of nutriment to every variety of plant; and thus, it would appear, exercises a benign influence in protecting men from the deleterious effects of poisonous vapors." "And if the effect," remarks La Roche, "is obtained, so far as regards one species of poisonous vapors, it may be equally so in reference to that giving rise to fever."

Many facts could here be collected, if the limits assigned to this article did not restrict me, to show that certain trees and vegetable productions, growing in damp, swampy, and malarial countries, possess the property of disinfecting them. The delta of the Mississippi, from the latitude of New Orleans down to the Gulf of Mexico, and west of the city, to its termination on the further side of Bayou Teche, abounds in lakes, and is traversed by a great number of small bayous. Herein are included the fine and flourishing settlements of the La Fourche, the Teche, and the Attakapas, all of which appear to be as little affected with autumnal or yellow fever as the Mississippi coast above the city. Nearly the whole surface of many of these bayous, and a considerable surface of many of these lakes, are covered in a greater or less degree with a great number of aquatic plants, both phænogamous as well as cryptogamous; but more especially with a large flowering plant, known by botanists under the name of *Jussieua grandiflora*, which grows three or four feet above the surface of the water, and gives the fallacious appearance of a natural meadow. To the influence of this plant Dr.

Cartwright ascribed the immunity of the region of country, where it grows, from fever; and adds, "I could find no other cause for the remarkable purity of the stagnant water in the lagoons, swamps, lakes, and bayous of lower Louisiana. * * * North of the region where the *Jussieua grandiflora* flourishes, there is the same kind of alluvial soil, formed by depositions of the identical rivers which form the soil of lower Louisiana; yet stagnant water, in hot weather, becomes exceedingly impure, beyond the limits in which the plant under consideration is found. The soil, therefore, cannot occasion the purity of the water of lower Louisiana, because the same kind of soil, a little further north, has not the same effect. I think it may be fairly inferred, therefore, that the aquatic plant consumes or feeds upon those substances which, in other situations, corrupt and vitiate stagnant waters in a warm climate."

It is not important to the point in view to know positively whether the healthfulness of the country just considered is due *exclusively* to this plant. The experiments of Maury with the sunflower (*helianthus*) go to show that other plants possess the same disinfectant property in malarial regions. But I allude more especially to the circumstance because of its relation to another fact of the same import in California. It was seen in our topographical sketch that the borders of the draining streams of the Sacramento Valley, especially near their point of exit, are marshy and overgrown with a wide expanse of *tulé* (*scirpus lacustris.*) This species of bulrush is very luxuriant, often attaining the height of eight to ten feet, and seldom less than six feet. It literally covers the swampy lands, and particularly all that extensive delta (as may be seen on the accompanying topographical map), formed by the union of the San Joaquin and Sacramento Rivers, before finding their way into Suisun Bay, at a break in the coast range. So far as our information extends, these *tularés*, or marshy lands, are exempt from malarial diseases.

A remarkable fact, specially worthy of insertion in this place, is one recorded in Sullivan's visit to Ceylon. "A large fresh-water lagoon, of a most green, slimy, tropical appearance, producing in abundance a lotus of almost Victoria Regia magnificence, stretches away to the back of the fort, and around are situated the bungalows of many of the Colombo merchants. The propinquity of this lake would, in any other tropical country, be considered as insuring a considerable amount of fever to the neighborhood; in fact, I doubt whether any advantage would induce a West Indian to locate in such position.

"However, in the matter of climate, Ceylon stands *per se*, and offers a total antithesis as regards the healthiness of certain districts of most other tropical countries. Whilst the vicinity of tanks and lagoons of the most fetid and aguish character is perfectly healthy, that of rivers is equally deadly. The apparent contradiction of the usual laws of nature is accounted for by two reasons. The tanks are covered with various kinds of aquatic plants, which, by a kind of providence, are made to serve not only as filterers and purifiers of the water itself, but even as consumers of a considerable portion of the noxious exhalations that would otherwise poison the neighborhood. The banks of the river, on the contrary, are rife with fever. The cause assigned is, that during the rainy seasons they swell to great size, and collect the vegetable matter of a large extent of country; but owing to the rapidity with which they fall at the commencement of the dry season, and the winding and intricate nature of their course, the streams are unable to clear

themselves, and this accumulation is left to decay in its bed and infest the surrounding country. There exists also another reason: the beds of the Ceylon rivers are almost invariably composed of sand, and the stream, instead of sweeping down the decomposed vegetable matter it holds in its waters, as must be the case in hard-bedded rivers, percolates through the sand, leaving the poisonous matter on the surface exposed to the burning rays of the tropical sun." As correlative, and calculated likewise to establish the protective power of trees also against malaria, I would mention in this connection another fact that once came within my own personal observation: Some thirty-five years ago, the streets of Charleston, South Carolina, were characterized by a very general growth of old umbrageous Pride of India trees (*Melia Azedarach*), whose cleanly verdure, free from, because poisonous to, insects, was as refreshing to the sight as the shade was grateful to the feelings during the almost tropical heat of the Summer months. But with the influx of northern merchants and Yankee enterprise came also the spirit of innovation, and this beautiful feature of one of our oldest southern cities was doomed to eradication by an ordinance of the City Fathers.

The very first Autumn after the extermination of the shade trees, the city, which had for many years enjoyed a perfect immunity from yellow fever, was afflicted with one of the most severe epidemics, and has been more or less subject ever since to an occasional return of the disease.

A distinguished natural philosopher—Changeux—inferred from the results of his experiments, that the action of trees and living vegetation in the production of the effect under consideration, is twofold. "Plants," he says, "whether odoriferous or inodoriferous, give issue to emanations which, when mixed with poisonous vapors exhaling from marshy or damp soils, neutralize their pernicious influence. But the former exercise a greater effect through means of the neutralizing process than by the power of absorption just mentioned, their emanations mixing with the air we breathe, and correcting its deleterious properties by virtue of the particular qualities with which they are endowed. The second class—the inodoriferous—on the other hand, act more, evidently, through the means of their power of absorption than the neutralizing property of their emanations, and remove from the air the vapors by which it is contaminated."

Senebier, in his *Physiologie Végetale*, and other expert observers, ascribe the disinfection, not to the absorption by trees and other vegetable productions of the gaseous poison floating in the atmosphere of malarial localities, but to the purification of such an atmosphere through means of the large supply of oxygen obtained from living plants, and the neutralizing agency of that gas on the mephitic particles it meets with in insalubrious places. As to the manner in which the oxygen thus produced destroys or prevents the elaboration of the malarial poison, some difference of opinion exists. M. Carriere, in his excellent work *Le Climat de l'Italie sous le Rapport Hygiènique et Médical*, adopts the views of Chevreul and Fontaine, in relation to the formation of the febrific poison through means of the action of organic matter on the sulphates contained on the earth, or in water, with the aid of the oxygen derived from the former. According to Carriere, the leaves of plants, and of trees, as well as the green substances that cover the soil, are all inexhaustible sources of oxygen, which is so important to sustain life and preserve health. This fluid, thus furnished, offers an obstacle to the

action of organic matter. If the latter acts chemically on the sulphates, the other, in its turn, reacts on those compounds, and from the double antagonistic action thus produced, a state of equilibrium advantageous to the purity of the air and the salubrity is reëstablished. Hence, to cover the fields, the borders of marshes, indeed, the whole extent of the soil, with an abundant vegetation, is to place on the surface of insalubrious regions a reparative apparatus of the greatest power.

But whatever may be the way in which trees and other living vegetable productions operate in counteracting or neutralizing toxical agents, floating in the air, it is a generally conceded fact, that they do exercise a powerful influence in promoting the salubrity of malarial localities, and hence their plantation becomes an important part of agricultural economy. In urging, therefore, attention to their general cultivation, we cannot do better than condense the following remarks in relation thereto, from the work of M. Carriere, just quoted, which are as applicable to California as to Italy:

Dry soils should be covered with those trees which resist the wind, and grow on the sides of mountains, as the oak and all its varieties. The willow, laurel, etc., will suit best the humid parts of the plains. The culture of the pine, which contributes so much to the decoration of the peninsular landscape, as well as of all evergreen trees, deserves much more attention than it receives. But this, as it were, ærial vegetation, does not alone suffice. There is another species of vegetation which must not be forgotten because it creeps over the soil and mixes with the waters. It is necessary that the means for the production of oxygen should be spread wherever this fluid can act, down even in the lowest places, wherever chemical elaboration is at work. The cereals cover the whole extent of the meadows (*maremmes*), especially in the Roman States. But the harvest leaves the earth exposed, during the hot season, to the solar rays. It is unnecessary to observe that this condition favors the development of miasmata, and gives power to epidemics—for it is well known that the fevers of Autumn are the most grave. Hence it is apparent that some other culture than that of the cereals would be more favorable to salubrity. If the vine, for example, was spread over the plains, as is practiced in the south of France, the soil would be protected until late in the Autumn; for the vine preserves its leaves until after the maturation of the grapes. In cultivating it for this object, a predominance must be given to the green expansion, or, in other words, to the productive apparatus of oxygen. In Italy, especially, in the environs of Naples, this end is obtained by marrying, as it were, the vine to the willow, to the young elms, or to other kinds of trees, and thus prolonging the stems or main stalks (*les ceps*) by the multiplication of their points of support. (1)

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(1) That such system of cultivating the grape in California is quite feasible, and was long ago recommended by me, the following extract from the *Sacramento Daily Union* of the twenty-second of February, eighteen hundred and fifty-nine, seems to establish:

"It is generally conceded that the citizens of our State have done more this season, in the way of planting grape vines, than in any previous year. Although the results will not be made manifest in the production of a crop immediately, yet the prospect is encouraging, in view of the successful development of the capabilities of our soil and an eventual supply of all our wants in this respect. Soil, suitable for the cultivation of the grape, is not confined to the valleys and plains of California, but may be found in every mining county of the State, and as extensive as the area of our gold fields. Indeed, it has been remarked that the grape raised on the sunny side of our mining hills is sweeter and more luscious, and produces a wine of more exquisite flavor, than the celebrated Los Angeles or Sonoma grape; or, other words, the latter grape is essentially improved in taste by being trans-

Besides these means, and in order the more effectually to subserve the cause of health, it would be advantageous to spread the alfalfa and other grasses, as the sedge, for instance, on the margins and in the beds even of the watercourses and canals, as well as on the dry land. By these means a product of oxygen would be gained, and stagnant waters and currents, with boggy margins, which stand so much in need of this gas, would not degenerate under the influence of the chemical decomposition of which they are the seat.

But the plantation of trees and shrubbery, and the general cultivation of the surface, are not the only modifying or ameliorating circumstances attending the improved salubrity of Sacramento, nor are these the only means of putting a stop to or mitigating the prevalence of fever or disease.

It is well known that since the season of eighteen hundred and sixty-seven–sixty-eight, there has been a considerable deficit in the annual average amount of rain in California; consequently, little or no stagnant water has remained in the sloughs or low places of the city, to pollute the vapor absorbed therefrom in the atmosphere, as was formerly the case. The effects, thus resulting from industrial as well as accidental causes, correspond precisely with the beneficial results obtained everywhere upon the draining of marshes, and the filling up of ditches, and other excavations, remarkable examples of which are on record. We might here dwell on the beneficial results of draining in Italy, Tuscany, France, and elsewhere, as well as on the effects produced by the covering of the marshy margins of river shores by sand-inundations, as observed on the borders of the Baltic, in Holland, in Africa, etc., and particularly on the well-known case of the Goodwin Sands, in which, while the usefulness of the land was destroyed, the salubrity of the vicinity was firmly established. We might also point out those instances in which the infection of a locality has been remedied by covering the focus of exhalation with earth, as was done in Gallipolis in seventeen hundred and ninety-six. But there are other considerations pressing upon our attention, and which will absorb all the space we can appropriate to the present subject.

In the foregoing remarks we have called attention to the salutary effects of perfect drainage, and of filling in, building up, and otherwise protecting by trees and vegetation low and humid places against the action of the solar rays, as exemplified in the sanatory condition of Sacramento. We now appeal to the past history of the same city, as affording one of the many instances on record, in which places, heretofore insalubrious, have been rendered otherwise by being thoroughly *washed*, as it were, through the agency of a freshet, or an inundation,

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planted to favorable localities in the mountain region. To such an extent has the grape been cultivated in the mining country, that individuals have already commenced the manufacture of wine for the market, although they find a ready sale for a large portion of the grape crop in their immediate vicinity. On this subject we append the following remarks from the Coloma *Times:*

"'The adaptability of our soil and climate for the successful cultivation of the grape is becoming more and more apparent. Only a few years ago it was thought that the southern portion, only, of our State was adapted to its cultivation. Experiments, however, have proved that grapes of as fine size and of equal or better flavor can be, and are now, grown in the central and northern portions of the State than in the southern. In the mining counties, the grape culturists have, as a general thing, had no difficulty in disposing of their fruit; but now there are so many who have turned their attention to this business, they will have to go into the manufacture of wine in order to use up their crops.'"

which carries off all substances susceptible of decomposition, and leaves in their stead a deposit of innocuous materials.

In a former report, already referred to, we mentioned the extraordinary freshet that was precipitated from the mountains and hills of California upon Sacramento, on the second of April, eighteen hundred and fifty-three; the diluvial effect of which was increased by the sudden melting of the snows above. For a long time after the subsidence of the waters, the inhabitants lived in filth and discomfort, and the surface of the ground everywhere was covered with mud and river deposit. Everybody predicted unusual sickness, but, to the astonishment of all, the City of Sacramento, which was notoriously unhealthy prior to this period, then maintained the high character it now enjoys for salubrity, and which is incontestably established by the mortuary tables already referred to.

In turning to the Transactions of the Pennsylvania State Medical Society, we find analogous instances recorded of floods with like results. Prior to September, eighteen hundred and fifty, intermittent fever prevailed to a great extent along the course of the Schuylkill, and was found, in many instances, to be unmanageable, showing a tendency to a frequent recurrence. But since the flood, which took place at the time mentioned, the same localities have been remarkably free from it. The same cause and effect have been observed by us in Louisiana; after the great crevasses of May, eighteen hundred and sixteen, and eighteen hundred and forty-nine, the City of New Orleans and neighboring country enjoyed uninterrupted immunity from malarial fevers.

Gouraud, in his treatise on *Fièvres Intermittentes Pernicieuses*, states that the City of Avignon was inundated on the thirtieth of October and the fourth of November by a rise of the Rhone. Nine tenths of the city was under water. No fever, however, followed, owing to the complete washing which the surface underwent, and the supervention of the cool north winds, which wafted the morbid exhalations along the great valley of the Rhone out to sea. Other analogous facts are related by Vitruvius respecting the lagunes of Venice, especially around Ravenna, Altina, and Aquileia; by Johnson, on Tropical Climates, and by Nicol, on the Climate of Seringapatam. At this latter place materials for putrefaction, for about eight months of the year, lie all over the banks of water streams, and other repositories, "until the periodical rains of Malabar begin, which, falling in the Ghauts, run down, and fill the Convery River. The filling of this river is always very sudden, and it comes rushing along with great impetuosity; sweeps out all the filth from the ditches, clears away all the impurities so long stagnant on the island, and leaves the place for a while tolerably healthy, and the air cool and refreshing." With equal propriety we may here call attention to the results obtained in some parts of the Pontine marshes, as well as in and about the Eternal City, as compiled by La Roche, from the writings of Tournon, Carriere, and others.

"In former days, that part of Rome on which the immense population was crowded, and which is now almost deserted, was healthy—comparatively so at least—while the insalubrious sections were the Campus Martius, the Velabrum, and other parts bordering on the river—the site of the modern city. The reverse is now the case; for as we approach the inhabited parts of the present city, through the space separating St. John of Lateran from the Forum and Velabrum, we pass over the principal focus of the pestiferous exhalations. On the other hand, the surface of the Campus Martius, or, indeed, the whole valley, is free from

the tainted atmosphere. The very section appropriated to the Jews—the Guetto—where the principles of public hygiene are sadly neglected, is, to a great degree, healthy. How has this happened? The Campus Martius was purified by Leo X, and the surface, after being divided into streets, was soon covered with houses, churches, and other buildings. The population, at the close of the reign of that pontiff, had already reached sixty thousand. The narrow valley between the Tiber and the Pincian Hill, by which we now enter Rome, was transformed from a vast marsh into the beautiful Piazza del Popolo; and other portions were, by successive pontiffs, greatly ameliorated. The site of the old city, which was not originally favorable to health, both on account of the peculiar condition of the soil and its exposure to the influence of distant sources of miasmal infection, but which had been rendered much less hurtful by drains, the erection of numerous aqueducts, and other works of kindred character, has returned to its pristine state. It has gone to destruction, and is now deserted. The houses and monuments by which it was covered have disappeared; the greater number of the aqueducts have been destroyed, with the effect of allowing the free escape of the water and the formation of marshes and pools; the drains have been choked up; and the whole surface presents a mass of ruins and rubbish."

The applicability of all that has just been stated, in a remedial or hygienic point of view, to the present condition of things in California, is too apparent to require any further comment at our hands. While urging, therefore, systematic and thrifty culture of the soil, with proper ditching and draining, as well as a careful handling of all products, and a general planting of trees in all parts of the State, especially on the sides of the irrigation canals and around the reservoirs, I wish to call special attention to a particular tree, which, it would seem, is well calculated to counteract and neutralize the evil effects which it is apprehended will result from the system of irrigation now adopted. I allude to

THE EUCALYPTUS GLOBULUS, OR BLUE-GUM TREE, OF TASMANIA.

Although the properties of this tree, in regard to the prevention of malarious disease, have in all probability been exaggerated, still there is strong evidence that it does exert an advantageous sanitary influence. As introductory to what I have been able to gather from reliable sources on the subject, I will first quote from a lecture recently delivered by Professor Bentley, before the Royal Botanic Society of England:

"The first and most important influence which this tree exerts, and that which has brought it more especially into notice, is its power of destroying the malarious agency which is supposed to cause fever in marshy districts; from which circumstance it has been called the 'fever-destroying tree.' It is in this respect commonly regarded as being serviceable in two ways: first, by the far-spreading roots of this gigantic tree acting like a sponge, as it were, and thus pumping up water and draining the ground; and, secondly, by emitting odorous antiseptic emanations from its leaves. Probably the influence of the latter is not small; although I am by no means of the opinion entertained by some writers, that these emanations are without effect, I do not certainly believe, as has been recently stated, that the branches of a solitary eucalyptus tree can have had any effect in neutralizing the malarious influence of a district previously constantly infected by fever;

but I do think that the foliage of groves of eucalyptus trees, by diffusing an agreeable, aromatic, camphoraceous, stimulating odor in the surrounding air, does have an appreciable influence in neutralizing marshy miasmas, and thus improving the healthiness of the district.

"But whatever be the cause or causes which render a marshy district thus comparatively healthy to what it was before the introduction of the eucalyptus trees into the neighborhood, the fact is unquestionable, and is now testified to in various parts of the world. Thus, at the Cape, in a very few years, the cultivation of the eucalyptus has completely changed the climatic condition of the unhealthy parts of that colony; and in Algeria, where it has been tried on a large scale in a district previously noted for its pestilential air and consequent prevalence of fever, not a single case now occurs, although the trees are not more than nine feet high; and in the neighborhood of Constantia it is also stated that at another noted fever spot, covered with marsh water both in Winter and Summer, in five years the whole district was dried up by fourteen thousand of these trees, and the inhabitants now enjoy excellent health. In Cuba, again, marsh diseases are fast disappearing from the unhealthy districts where this tree has been introduced. In the Department of the Var it is also said that a station house, situated at one end of a railway viaduct, so pestilential that the officials could not be kept there longer than a year, is now as healthy as any other place on the line, in consequence of the planting of a few eucalyptus trees. Numerous other instances might be cited to the same effect as having occurred in France, Spain, Italy, Germany, and other parts of the world; and we cannot doubt, therefore, that although the effects have been to some extent probably exaggerated, the statements are substantially correct, and that this tree does possess a most beneficial effect in neutralizing and improving the malarious influence of marshy districts.

"The timber of many species of eucalyptus is remarkable for its solidity, hardness, and durability, and for its power of resisting the attacks of insects and the teredo, as also the influence of moisture. Baron von Muller found that the ashes of these trees 'contained a larger proportion of potash than the elm or maple, which are the trees most esteemed for that purpose in America. The yield from the latter trees is estimated at ten per cent of the ashes, while that from the eucalyptus is twenty-one per cent.' The barks of many species are also used extensively for tanning. A number of species also exude a very astringent substance, which, from its resemblance to the ordinary medicinal kino both in appearance and properties, is commonly designated as eucalyptus or Botany Bay kino. It is employed for the same medicinal purposes as our officinal kino, and also for tanning and dyeing. Another substance, called eucalyptus or Australian manna, is also yielded by several species. It occurs in small, rounded, opaque, whitish masses, with an agreeable, sweet taste. It has a similar action to the ordinary manna, and contains somewhat similar constituents. Another important product of the eucalypti is the essential oil. This oil is stored up in the pellucid glands contained in the leaves, and readily observed when these are held up to the light, by the semi transparent appearance they then exhibit. The oil chiefly consists of a substance called by its discoverer, Cloez, *eucalyptol*, a liquid body, in chemical characters, resembling camphor. From the quantity of oil contained in the leaves, they yield, when burned, a very large proportion of gas; and it is said that one of the

towns in the gold regions was for a long time lighted by gas extracted from this source.

"The febrifugal properties of the bark and leaves of this plant have been testified to by many practitioners. Probably some of the exaggerated statements that have been made in reference to the efficacy of eucalyptus bark and leaves in fevers have arisen under the mistaken idea that the bark contained an alkaloid resembling, if not identical with, quinine, the well known alkaloid of cinchona barks. But Broughton, the Government chemist of Ootacamund, upon careful examination of the bark and leaves, states that neither quinine nor the other alkaloids of cinchona bark exist in the plant in any proportion. What properties the plant possesses would appear, therefore, so far as known at present, to be due essentially to the presence of eucalyptol, already noticed as the principal constituent of eucalyptus-oil. From the testimony of numerous medical practitioners in various parts of the world where the plant has been introduced, and from its popular reputation in fevers in Australia and other countries, we can scarcely doubt that it does possess antiperiodic properties, although these are far less important than those of cinchona bark.

"When, therefore, we regard the beauty of the different eucalypti, and the proved influence of *E. globulus* in improving the pestilential character of marshy districts, the genus must be regarded as one of the most important to man in the vegetable kingdom."

Turning now to the *Comptes Rendus* of October sixth, eighteen hundred and seventy-two, we find a note presented to the French Academy of Sciences by M. Gimbert, in which the writer says: "A tree [like the eucalyptus] springing up with incredible rapidity, capable of absorbing from the soil ten times its weight of water in twenty-four hours, and giving to the atmosphere antiseptic camphorated emanations, should play a very important part in improving the health of malarious districts." The writer furnishes a few of the numerous results, which are interesting.

The English were the first to experiment in their sanitary plantations in Cape Colony, where they were eminently successful. Two or three years were found sufficient to change the climatic conditions and the aspect of the malarious district of their possessions.

Some years ago the Algerians took occasion to spread the eucalyptus throughout the French possessions in Africa, and the following are some of the results obtained as communicated by M. Trottier:

"About twenty miles from Alger, at Pondouk," he says, "I owned a property situated near the River Hamyze, the emanations from which produced intermittent fever among the farmers and their servants every year. In the Spring of eighteen hundred and sixty-seven, I planted upon this farm thirteen thousand plants of the *eucalyptus globulus*. In July of that year, the season in which the fevers appear, the farmers were completely free from them. In the meantime the trees had scarcely attained a height of more than eight or ten feet. Since that time the settled population has been entirely free from fevers."

Fourteen thousand eucalyptus trees were planted upon the farm of Ben Machydlin, in the vicinity of Constantine. It has for several years past been noted for its insalubrity, being surrounded with marshes throughout the entire year. The trouble entirely disappeared, and the soil became perfectly dry in five years. The atmosphere is constantly

charged with aromatic vapors, the farmers are no longer troubled with disease, and their children are bright with health and vigor.

The operations of the manufactory of Gué in Constantine were rendered wholly impracticable during the Summer, on account of the pestilential emanations from the marshes with which it was surrounded. M. Saulier conceived and put into practice the idea of planting a large number of eucalyptus trees in these marshes, and in three years about twelve and a half acres of the marshy soil were converted into a magnificent park. The water completely disappeared, and the health of the workmen has since been in good condition.

In consequence of the large grove of *eucalyptus globulus* on the farm of Maison-Carrée, which is situated in a district in which the inhabitants formerly succumbed to the malaria, similar hygienic revolutions have taken place.

It is stated by land owners in Cuba that there also the paludal and telluric diseases have disappeared from the malarial districts where the eucalyptus has been cultivated.

According to Ramel, Australia is very healthy where the eucalyptus flourishes, and unhealthy where the tree is not found.

On the banks of the Var, near the entrance of a railroad bridge, is situated a garrison house, near which earthworks were thrown up to dam the river in order to build the bridge. The malaria arising from it made it necessary to change the guard each year. Two years ago, M. Villard, the engineer in charge of that section of the road, planted forty trees in the vicinity of the building, and since that time this post has been the most healthy in the country.

In the *Archiv der Pharmacie*, November, eighteen hundred and seventy-four, Dr. I. Homeyer has an article of over twenty pages on its leaves, and their ethereal oil. It is illustrated by several wood cuts, and he concludes that the oil consists of two turpentines, and of cymol.

Dr. G. Vulpius, in the same journal, attributes to this ethereal oil the beneficial effects of the eucalyptus on miasmatic localities.

Mr. J. Bosisto, President of the Pharmaceutical Society of Victoria, points out that the eucalyptus probably exerts its influence in this respect: first, physically, by powerful root action in absorbing humidity from the earth; by its being evergreen, and in continuous action; by the abundance of its leaf surface; by its evaporation of water, oil, and acid under a perpetually genial atmosphere; and, chemically, by the power of its volatile oil, and volatile acid, abundantly present in the plant and air, to produce peroxide of hydrogen.

While this paper is going through the press, we gather the following from the "Medical and Surgical Reporter," of Philadelphia, August, eighteen hundred and seventy-five:

"We are not without hope that the eucalyptus will redeem its reputation. Dr. Cosson recently announced that its effect in Algeria has been very marked. Since the growth of plantations of this tree around the Lake of Fezzara, the malaria, which formerly was intense, has almost disappeared.

"The village of Ain Mokra, according to Captain Ney, furnishes an equally striking instance. The station was formerly so unhealthy that it was necessary to change the French garrison every five days, on account of the number of men attacked. Fever has, however, become much more rare since plantations of *eucalyptus globulus* have been made on the shores of the lake, and the sides of the railway, which include,

altogether, sixty thousand trees. A writer in the Paris *Temps* mentions a still more singular effect: namely, that parasites (*phylloxera*, etc.) disappear from vines growing near the eucalyptus. The experiment, made during several years, and in several vineyards, has been uniform in its result.

"It is interesting, in connection with these facts, to observe that the leaves of this plant contain an ethereal oil, of which even half-dried leaves contain six per cent, and that this oil, according to Gimbert, is a very powerful antiseptic. It will preserve blood and pus as long as carbolic acid (five months and more), and far longer than oil of turpentine. It prevents also the appearance of fungi or vibrios. These observations have received independent confirmation from Binz, in Germany."

These evidences go far to establish the fact, that the *eucalyptus globulus* has a good effect in preventing the spread of malarial diseases, and that it may serve decidedly practical purposes in this particular. But the most remarkable accounts from the eucalyptus tree are those that come from nearer home. We find in the Kern County *Courier* an indorsement of the claims of this tree, which we copy, being confident that it will inspire confidence in what we have said on this subject. The editor of the *Courier* derives his information from personal observation, he being the owner of a farm upon which the matter was tested. He states his observations and experiences as follows:

"We speak somewhat positively in regard to the sanative or anti-malarial influence of the eucalyptus. If all, or even part of the evidence we have read on the subject, coming from sources entitled to the utmost confidence, is true, we are certainly justified in so doing. But we are not accustomed to speak positively, or to say in effect we know, unless we have the evidence of our own observation or personal experience. In regard to the anti-malarial influence of the eucalyptus, we have this conclusive evidence. We have given it what we regard as a reasonably fair test on our own farm. This is cultivated by two families, or companies, of Chinese. One company lives near the north and the other the south end of the premises, about three fourths of a mile apart. The localities both parties inhabit are favorable to the development of malaria. The soil is rich, moist, and teeming with vegetable life, and the free sweep of the prevailing wind is obstructed by the intervention of dense thickets. As might be expected, they have, every year, during the heated term, suffered with malarial fever. Last Winter we determined to test the much vaunted virtues of the eucalyptus. In February we gave to the party at the north end two ounces of the seed, with directions that it should be planted near the house. It germinated finely, and produced several thousands of young plants, but the frost killed most of them. About twelve hundred, however, survived. These, when the heated term commenced, had attained an average height of two feet, and emitted a strong aromatic or camphorous odor, perceptible at a distance of a hundred yards. In due time the party at the south end were visited by their usual mildly-distressing fever, but up to the present time we have looked in vain for the first symptoms to develop in the other. They are all, to their own astonishment, in the most robust health. These trees now average more

than three feet in height, and the atmosphere of the house is strongly impregnated with their odor. We have investigated in vain for other causes to which to attribute the anomalous state of health of the inmates, and can find none but the reputed sanative properties of this tree. We have finely become convinced from the evidence of our own senses that it will do all the current accounts given of it allege, and propose, the coming season, to plant it on all the waste places and corners on our farm we can spare from other purposes. If everybody would do likewise, the great valley of Kern County might soon take rank among the sanitariums of the State, because as yet no disease, except a mild type of malarial fever, has shown itself. Every land owner, be his possessions large or small, should put it in the light of a duty to plant more or less of the eucalypti."

The foregoing testimonials afford some idea of the interest which has taken root in the public mind, with regard to this tree, not only in California, but in many diverse portions of the earth. This interest, it would seem, is almost of as rapid growth as that of the tree itself. The testimony of the medical profession, too, while it is not so extravagantly sanguine as that of the laity, is, nevertheless, generally encouraging. To the separate question devoted to this subject in the circular, viz: "*Do you know of any instance in which the planting of trees, and especially of the eucalyptus, has exercised a modifying influence on malarial or intermittent diseases?*"—the answers from medical men have all been to the effect that the period of observation and experience has been too short to authorize the expression of any positive opinions. The following reports and communications, however, possess much value in this connection:

[Extract from the Annual Report of the Board of Directors of the California Pharmaceutical Society, October 9th, 1872.]

The remedial powers of the *eucalyptus globulus*, a native of Australia, are receiving much praise from various portions of the world.

This tree (for such it is) is the subject of an important memoir by Professor Gubler. It belongs to the natural order *myrtaceæ*—the same that furnishes the clove, pimento berry, also the *melaleuca muriari*, which yields cajeput oil. The species of eucalyptus grows often to a gigantic size, some of the genus eclipsing even the famed *sequoias* of our own State. It is impregnated in all portions with a peculiar aromatic substance, most abundant, however, in the leaves and flowers, which yield by distillation about four per cent of a fragrant volatile oil; this is mobile, nearly colorless, and has a camphoraceous odor. (The odor of the leaves very nearly resembles that of cajeput oil.) By fractional distillation it is separated into several constituents, of which the most interesting has been described by M. Cloez under the name of eucalyptol. By collecting the most volatile portion from the oil by distillation—redistillation from caustic potash and chloride of calcium, a product boiling at 175° centigrade, deflecting the ray of polarization to the right, and incapable of congelation, is obtained, having the formula $C_{12}H_{20}O$, which is the substance in question. It is very soluble in alcohol, which solution, when highly diluted, is eminently a perfume. Cooled to zero and subjected to the action of gaseous chlor-hydric acid, absorption of the gas takes place, accompanied with an abundant crystallization; these crystals, however, are not permanent, spontaneous

decomposition taking place in a short time with the production of an aqueous solution of chlor-hydric acid, and a peculiar hydro-carbon, boiling at 168° centigrade. The action of anhydrous phosphoric acid upon it yields a liquid hydro-carbon boiling at 165° centigrade, and having a specific gravity of .835 at 12° centigrade (that of eucalyptol being .905 at 8° centigrade), and has the formula $C_{12}H_{18}$, differing from eucalyptol in its loss of the elements of water. It has been named eucalyptene. In the reaction a polymer of eucalyptene is formed, which boils at temperatures not exceeding 300° centigrade. The hydro carbon formed by the spontaneous decomposition of the crystals, formed from the action of chlor-hydric acid gas upon eucalyptol, is also thought to be eucalyptene. Eucalyptol prevents, in a remarkable degree, the development of cryptograms. Solutions of the organic alkaloids prepared with an aqueous solution of the same, remain clear for a long time after those prepared with pure water are turbid with confervoid growths. It has been stated that the *eucalyptus globulus* contains a peculiar alkaloid, but as neither Cloez or Gubler obtained it, its existence is uncertain. Alkalies give with the aqueous solution a voluminous precipitate but slightly soluble in alcohol, ether, or water; to water and alcohol it imparts a pinkish tinge. The precipitate is readily soluble in dilute acids, which solutions are colorless, or nearly so (being completely decolorized by an excess of acid), and yield upon neutralization, even after treatment with animal charcoal, a deep purplish black precipitate. A hot alcoholic tincture of the leaves upon cooling, lets fall a precipitate which, when purified by solution in boiling alcohol, separates on cooling as a bulky, greenish white precipitate. Neither this, nor the one obtainable by precipitation of the decoction, have been sufficiently studied. Experiments are in progress by a member of this society, and the results will in due time be published.

The leaves of the tree, contrary to expectation, yield no camphor, unless we consider eucalyptol, which indeed appears to be the homologue of ordinary camphor, as such.

This species of eucalyptus is common in and about San Francisco, and is easily cultivated. It is the "Blue Gum" of Victoria and Tasmania, and is known in Spain as the "fever tree," from its efficacy in the treatment of intermittents, having effected cures in which quinine had failed. It is a tree of extraordinarily rapid growth, having been known to increase in height half an inch in twenty-four hours. As a remedial agent it has been exhibited in many forms, viz: the powdered leaves, infusion and decoction, aqueous and alcholic extracts, tincture and in cigarettes.

The tincture has been used with benefit in asthma, by inhalation. Eucalyptol has also been exhibited in pills and capsules, and is recommended in emulsion.

In July, eighteen hundred and seventy-two, Mr. R. E. C. Stearns read before the California Academy of Sciences the following paper:

ON THE ECONOMIC VALUE OF CERTAIN AUSTRALIAN FOREST TREES, AND THEIR CULTIVATION IN CALIFORNIA.

Australian forest trees propagated from the seed, with perhaps a few exceptions, thrive remarkably in California; the climate and soil appear to be nearly or quite as favorable to the growth of these exotics as of the native forest forms.

In many of the principal towns in this State, especially in and around San Francisco, in the neighboring City of Oakland, and adjoining towns on the easterly side of San Francisco Bay, fine specimens of many of the Australian forest species are exceedingly numerous. The most popular of these belonging to the genera *Acacia* and *Eucalyptus*, have been planted for ornamental and shade purposes; the light feathery fern-like foliage of some of the acacias, their gracefulness, beauty and color, combined with rapid growth, present so many advantages as to fairly entitle them to popular esteem. Of the acacias recommended by Dr. Mueller on account of their economic value, (1) I am not aware of any being cultivated in this State for that object. *A. decurrens* (=*A mollissima*), also *A. lophantha*, and some other species, are frequent, and highly prized for ornamental purposes. From twenty to thirty species are enumerated in the catalogues of the principal nurseries.

The many valuable properties of the species mentioned in the foot-note, combined with rapidity of growth, would warrant cultivation on an extensive scale, which, if judiciously conducted, would be highly advantageous to the State, and yield a handsome return upon the capital invested. Mueller says that the wood of *A. decurrens*, popularly known as the "Black Wattle or Silver Wattle," can be used for staves, but its chief use would be to afford the first shelter, in treeless localities, for raising forests. Its bark rich in tannin, and its gum not dissimilar to gum arabic, render this tree also important.

A. homalophylla has a "dark brown wood, is much sought for turners' work on account of its solidity and fragrance. Perhaps its most extensive use is in the manufacture of tobacco pipes."

A. melanoxylon "is most valuable for furniture, railway carriages, boat building, casks, billiard tables, pianofortes (for sound-boards and actions), and numerous other purposes. The fine grained wood is cut into veneers. It takes a fine polish, and is considered equal to the best walnut." Under favorable circumstances, it attains "a height of eighty feet, with a stem several feet in diameter." This species requires a deeper and moister soil than *Acacia decurrens* and *Acacia lophantha*, which are especially recommended for their ability to resist drought, and therefore particularly applicable to treeless and sterile areas in the southern part of California, and the adjoining country, where the temperature does not decline below ten degrees.

The peculiar yellow displayed in the China silks and other articles, is obtained from the yellow flowers of a species of acacia, and is of an exceeding permanent character.

The acacias are easily propagated from seed, as I have (with some species) practically tested; and it is not unlikely that the flowers of most of the species, which are yellow, might be equally as valuable for the dyer, as the variety cultivated or used by the Chinese.

Of the Eucalypti, *E. globulus* is very common in California, and easily cultivated; it is the blue gum of Victoria and Tasmania. "This tree is of extremely rapid growth, and attains a height of four hundred feet, furnishing a first-class wood. Shipbuilders get keels of this timber one hundred and twenty feet long; besides this they use it extensively for planking, and many other parts of the ship, and it is considered to be generally superior to American rock elm. A test of strength has been made between some blue gum, English oak, and Indian teak. The blue

(1) A. decurrens, *Willd*, also A. homalophylla, *Cunn*, and A. melanoxylon, R. Br.

gum carried fourteen pounds more weight than the oak, and seventeen pounds and four ounces more than teak, upon the square inch. Blue gum wood, besides for ship building, is very extensively used by carpenters for all kinds of outdoor work, also for fence rails, railway sleepers—lasting about nine years—for shafts and spokes of drays, and a variety of other purposes." (1)

Of the rapid growth of this species of eucalyptus and the facility with which it is propagated, most people in California who have had any experience with it are familiar; but as perhaps few persons who have specimens of it growing upon their grounds or in their yards are aware of its value otherwise than for ornamental purposes, I have deemed it a matter of interest as well as of importance to quote from Dr. Mueller's valuable paper. Having propagated the blue gum from the seed and raised many specimens under not particularly favorable circumstances, I can indorse the remarks of the author from whom I have quoted. An instance of rapid growth immediately under my observation, is that of a specimen purchased by me of a nurseryman, which at the time of planting (January fifth, eighteen hundred and seventy-one) measured from the ground level to the extreme tip six and one half feet, and in about eleven months (December eighth, eighteen hundred and seventy-one,) had reached a height of a trifle over fifteen feet; the diameter of the stalk when set out was half an inch, and at the final measurement one and three quarter inches. I am prepared to hear of instances far exceeding my figures, but it should be borne in mind that we had very little rain after this tree was planted, and furthermore that the locality was upon nearly the highest ground in Petaluma. This tree was occasionally but only moderately watered during a part of the time. Other trees of this species planted at the same time, also made a remarkable growth; specimens raised by me from the seed, whose growth I have noted, show a gain of ten and a half inches in twenty-one days, or half an inch per diem.

The development of the lateral branches is as surprising as its perpendicular growth.

George C. Potter, Esq., of Oakland, informs me that specimens upon his grounds nine years old, show a diameter of twelve inches.

Of a large plantation of eucalyptus of the blue and red species made a few years ago by Mr. J. T. Stratton, (2) of Alameda, I hear indirectly that the trees have done well. I hope at a future meeting to be able to learn from Mr. Stratton, and inform the Academy more definitely of the success thus far, and prospects of this highly commendable and important enterprise. (3)

The many valuable properties of the eucalyptus attracted the attention of the French Government several years ago. A specimen in the Jardin d'Acclimation, at Algiers, excited the admiration of the Emperor while on a visit to that place, and upon measuring the tree it was found, according to the Paris *Moniteur*, to have made "a height of thirty feet and a diameter of six inches in two years." Since that time it has been

(1) Vide "The Principal Timber Trees Readily Eligible for Victorian Industrial Culture, etc., by Ferd. Von Mueller."

(2) Report of the Commissioner of Agriculture, 1870, p. 232.

(3) I do not refer to other forest plantations made in California, by Mr. Aiken or Mr. Edwards, and which I sincerely wish may be successful, for the reason that in this paper the chief object has been to call public attention to certain Australian forms.

extensively cultivated in Algiers, and of late it has been stated that it "is making rapid progress in the south of France, Spain, and Corsica, especially on account of its alleged virtues as a remedy for fever. It furnishes a peculiar extractive matter, or alkaloid, called eucalyptine, said by some to be as excellent a remedy against fever as quinine.

In Spain its efficacy in cases of intermittent and marsh fevers has gained for it the name of "fever tree." It is a powerful tonic and diffusible stimulant, performs remarkable cures in cases of chronic catarrh and dyspepsia, is an excellent antiseptic application for wounds, and tans the skins of dead animals, giving the fragrance of Russia leather. The tree prefers a marshy soil, in which it grows to a great height very rapidly. It dries the earth under it by evaporation from its leaves, and shelters it from the sun, thus preventing the generation of marsh miasm" (1)

Of the medicinal properties of *Eucalyptus globulus* we have additional testimony in a recent number of the Practitioner, (2) where Dr. M. C. Maclean relates the results of his experiments on patients in the hospital wards at Netley, England. He says, in connection with certain cases of chest aneurism and cardiac asthma: "With the exception, perhaps, of the subcutaneous injection of morphia, I know no remedy so efficacious in allaying pain, restoring dyspnœa, calming irritation, and procuring sleep in such cases, as to be compared to *Eucalyptus globulus*." He also refers to the use in Germany of a tincture made of the leaf, which "has been used successfully in ʒ ij doses in the treatment of intermittent fevers." It appears that it is not only used medicinally in form of a tincture, but also that cigars are made from the leaves, and its palliative influence obtained by smoking.

"German physicians, as appears from medical journals, have found a tincture of the leaves of the *Eucalyptus globulus*, or Australian gum tree, to be a remedy for intermittent fever. Dr. Lorimer gave it to fifty-three patients, of whom forty-three were completely cured. In five others there was a relapse, owing to a failure in the supply of the tincture. In eleven of the cases quinine had been used without effect, and nine of these were cured by the eucalyptus." (3)

Other species of the eucalypti, of great value and well worthy of consideration, are recommended by Dr. Mueller.

E. amygdalina, Labill, which is sometimes met with four hundred feet in height; one specimen in the Dandenong ranges measured four hundred and eighty feet, (4) surpassing in altitude the gigantic *sequoias* of our own State. The wood of this species is said to be well adapted for "shingles, rails, house building, for the kelson and planking of ships, and other purposes." In rapidity of growth it equals *E. globulus*, but is not so easily satisfied with any soil.

E. diversicolor, F. v. Mueller, a native of S. W. Australia, sometimes reaching four hundred feet in height, with a proportionate growth of stem. The timber is excellent, and young trees are reported as doing well even "in dry exposed localities in Melbourne." It is regarded by Dr. Mueller as a valuable shade tree for avenues, as it makes a dense growth.

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(1) Harper's Magazine, March, 1872; Scientific Record, p. 630.

(2) No. XLI, p. 268, Nov., 1871.

(3) Annual Record of Science and Industry, 1871, p. 586.

(4) Trans. and Pro. of the Royal Society of Victoria, Part I, Vol. VIII, p. ix.

The *Eucalyptus citriodora*, Hooker, a native of Queensland, "combines, with the ordinary qualities of many eucalypts, the advantage of yielding from its leaves a rather large supply of volatile oil, of excellent lemon-like fragrance."

E. gomphocephala, Candolle, grows to a height of "fifty feet, wood close grained, hard, and not rending."

Eucalyptus marginata, Smith, "the Jarrah or mahogany tree of S. W. Australia, famed for its indestructible wood, which is attacked neither by chelura nor teredo, nor termites, and therefore so much sought for jetties and other structures exposed to seawater, also for underground work, and largely exported for railway sleepers. Vessels built of this timber have been enabled to do away with copperplating. It is very strong, of a close grain, and a slightly oily and resinous nature; it works well, makes a fine finish, and is by shipbuilders here considered superior to either oak, teak, or, indeed, any other wood." The tree does not grow as rapidly as the blue gum in the neighborhood of Melbourne, but Dr. Mueller expresses the opinion that it would make a rapid growth in a more favorable locality.

The *E. rostrata*, Schlecht, the red gum of Victoria, is a very valuable species for the "extraordinary endurance of the wood underground, and for this reason highly valued for fence posts, piles, and railway sleepers; for the latter it will last a dozen years, and if well selected, much longer. It is also extensively used by shipbuilders for mainstem, sternpost, innerpost, deadwood, floor timbers, futtocks, transoms, knightheads, hawsepieces, cant, stern, quarter, and fashion timber, bottom planks, breasthooks and riders, windlass, bowrails, etc. It should be steamed before it is worked for planking." Next to the Jarrah from W. Australia, this is the best wood for resisting the attacks of seaworms and white ants. This species reaches a hundred feet in height, which is also the height of the next and the last of the eucalypti referred to herein, viz: *E. sideroxylon*, Cunn, which produces a wood of great strength and hardness, and desirable for carpenters, shipbuilders, and wagonmakers, being suitable for wheels, treenails, belaying pins, and is considered the strongest wood in the colony; also valuable for railway sleepers, underground work in mines, etc.

The wood of the gums is "so soft at first as to render the felling, splitting, and sawing up the tree, when green, a very easy process, but when thoroughly dry becoming as hard as oak." (1)

When we consider the fact of the great number of farms in California that are nearly or wholly destitute of wood, and the great and continuous expense entailed by our system of fencing, the importance to the farmer of dedicating a portion of his land to the cultivation of forest trees, from which he can obtain fuel and fencing materials, is too palpable to admit of debate. The comparatively small expense and labor with which the cultivation of a few acres for the purposes I have named is attended, its absolute feasibility and practicability, with the beneficial results that would flow therefrom, should commend itself at once to every farmer, as a few acres of timber land for economic purposes would add much more than the cost to the cash value of the farm. The boundaries of a farm should be marked by a row or rows of trees, thus defining its limits by living monuments, and greatly adding to its beauty. From these rows, as the trees advance in growth and age, some wood

(1) Baird's Dict. Nat. Hist., p. 235.

could be cut, and where the farm is of considerable size, enough in the way of trimmings or prunings to supply the fuel of the house. In the treeless areas of the southern part of the State, the varieties of acacia above named would prove an important aid in assisting, by their protection, the planting of other species of timber, as they are easily taken care of, and will stand excessive drought. They would also be useful, as is our Monterey cypress (*cupressus macrocarpa*), for belts to break the force of the winds in exposed places, and it is to be hoped that before many years, timber belts for this purpose will be common wherever the coast winds prevail, as a protection to the orchards and vineyards.

We have many native trees well adapted for timber or wind-breaks; and while calling the attention of land owners and others to the exotic forms above mentioned, and their special qualities as enumerated in Dr. Mueller's excellent paper, I do not wish to be understood as making an unfavorable comparison as against indigenous species, as for some of the purposes mentioned they will answer equally well.

It must be remembered, however, that our forests are unfortunately deficient in many of the hard woods much used in the arts, and which we are now compelled to import from localities more favored in this respect. The aggregate amount annually sent out of the State for the purchase of this material, could, by proper foresight and enterprise, in a few years, be retained within our own borders, and here expended in the establishing of new industries pertaining to the very material, the manufacture of which in other portions of the Union employs large communities, to whose support we are now contributing.

As in Germany, to anticipate a future need, our own *Sequoia sempervirens*, or redwood tree, is extensively cultivated; so here, by the cultivation of the Australian eucalypti, we can, in a few years, supply a positive want, and reap the advantages above indicated.

Since the reading of the above paper, I have had many questions asked me by persons not present at the meeting of the Academy, and as an answer to said inquiries, and to various propositions, I have added the following:

Some objection has been made to the acacias and eucalypts, by persons who have planted them for shade or ornamental purposes in the vicinity of San Francisco, for the reason, as alleged, that they do not withstand the winds. So far as the observations of myself, and others who have investigated the matter, extend, it is really surprising that so few are prostrated. The fault is not with the trees, but the purchaser; as trees of from four to six feet in height are sold at a low price, they are bought by parties who require only a few in preference to smaller trees, as they make a greater immediate show. As most of the growth of the trees, as usually purchased, after having attained a height of six inches, has been made in the pot or box in which they are sold by the dealers, it will readily be perceived that the tap-root, which, in a natural state, descends, is diverted from a perpendicular into a rotary direction, analogous to a spiral spring, and is also crossed and recrossed on itself, with the liability, as it increases in size, to strangle the tree, by one portion of this root making a short turn or twist upon another part of the same, or by being wound about and restricted by the lateral roots. It is therefore apparent that the better policy would be, even where only a few trees are wanted (and this remark applies with equal pertinence to all trees), that, other things being equal, such as comely shape and healthy condition, the younger and smaller trees are really cheaper at

the same price than the larger, and can generally be obtained for much less. For forest culture, the smaller trees are indispensable to success.

Again, it is frequently the case that the lower branches are trimmed off to a mischievous extent, which also is a mistake; for where a tree has sufficient space to grow in, but little trimming is necessary, and it is a false taste which seeks to improve (?) upon nature by depriving a tree of its normal physiognomy and distinctive character by carving it into grotesque or inappropriate shapes; it is simply mutilation, and is certain to result in the premature decay and death of the victim. The flattening of the head by certain aboriginal tribes, and the distorted feet of the fashionable Chinese ladies, are further and pertinent illustrations of analogous hideous violations of natural form.

The annexed letter from Dr. W. P. Gibbons, of Alameda, contains so much practical knowledge in regard, especially, to the cultivation of the eucalyptus, that I here insert it for the benefit of the public, although the author did not write it for publication:

I am sorry to say that I can contribute nothing of my own experience which is calculated to throw light on the medical properties of the *eucalyptus globulus*. Though I have frequently used it, the results are not such as to warrant any general conclusion of its therapeutic value. I am not entirely clear in my own mind as to the species intended to be designated as "blue gum." According to Wools, as well as Mueller, there are three species popularly recognized as "blue gum:" *blue gum, flooded gum, and Cumberland gum*, are names of the *eucalyptus goniocalyx;* a tree of small growth in some localities, and in others attaining two feet diameter in thirty years. It generally attains, however, a height of seventy or eighty feet, and a diameter of seven feet. It is valued for its timber, for building and other purposes. In Western Australia, on the Mittagory Range, is the mountain blue gum *eucalyptus engenioides*, the wood of which is considered inferior to the *goniocalyx*. The *Tasmanian blue gum* is the *eucalyptus globulus*. In its native localities it is subject to the ravages of beetles. This is the species, which is so commonly known (whether correctly known, I am unable to say,) throughout California. * * * As to the cultivation of the tree, the gist of the matter is this: gardeners pot the young plants, and, after they have so grown for a year or more, they send them to market. A potted tree always has distorted and horizontal roots. Hence, if placed in the ground without root-trimming, it will always maintain a spiral and circumscribed growth. Thus we see a root, so distorted, has no chance of sending off side growths and perpendicular growths, which will anchor the tree in soil. A potted tree should always be well trimmed in the roots, so as to give a chance for young, vigorous, and spreading branches. Don't leave long and twisting roots upon them.

Again, the tree should never be trimmed up. The young tree has a different leaf from the old one. For two or three years nothing but nursing leaves grow upon it. These leaves are larger, and present a

much greater respiratory surface than subsequent leaves. They are necessary to give development to the root. As soon as the adult leaves are developed, the side branches, bearing the milk leaves, die off. The tree should never be topped, as this would spoil its beauty, mar its growth, and render it more liable to be blown over during high winds. All the foregoing precautions are advisable to prevent this accident. Calculate the area of foliage exposed to wind, and the resultant direction of force there applied, and you will see the point.

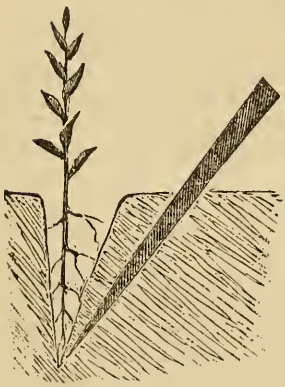
It is as impossible for a healthy tree that has been well root trimmed and planted, to blow over, as it is impossible for a potted tree, headed off and carelessly planted, to stand a storm. By planting them ten feet apart, they will support each other during wind storms. I would recommend the planting of several species. The *E. vinsinalis* is a very graceful tree, yielding a substance called manna. It grows one hundred and eighty feet high and eight feet in diameter; the wood is not much esteemed. The *E. colossea* grows four hundred feet high; is more bushy than globulus, and of more rapid growth; the timber is good. The *E. amygdalina* has been known to grow four hundred and eighty feet high. The *E. eugenioides* is of fine growth, one hundred and fifty feet high. By multiplying the number of species planted, we insure some from disease and premature decay.

From the *Rural Press* we gather the following additional information respecting the seeding and planting of this tree, from the same authority above referred to:

Plant your seed immediately, in a box twelve inches deep, containing eight inches of clean, rich loam, by dropping the seeds on the surface, about an inch apart, and covering them with a quarter of an inch of sawdust, or by sifting vegetable mold over them to a like depth. The common method of placing the seed in three or four inches depth of soil, is objectionable, as the roots soon penetrate to the bottom of the box, and are bent off at right angles to the axis of the plant. This distortion prevents the tree from having such a firm hold in the soil, as it otherwise would. Hence so many eucalyptus trees blow over after having a growth of four or five years. Their germination may be facilitated by soaking them for twenty-four hours in a pint of warm water, in which a piece of saltpetre or carbonate of ammonia about the size of a marble, has been dissolved. Place the box in your kitchen, or some other warm locality where sunlight will reach it, cover it with glass or a piece of board, and keep the soil watered every day, sufficient

to give a decidedly moist character thereto; if possible, keep up a temperature of about seventy-five degrees Fahrenheit, during the daytime, until the seeds sprout. When they are half an inch high, remove the covering, and give them sunshine. They will grow more slowly, but the plants will be more hardy and vigorous. When they are four inches high, they should be gradually seasoned to out-door temperature, so that they may be ready to transplant as soon as frosts disappear. You will then have trees from four to six inches high, growing in a depth of soil which will insure straight and vigorous roots.

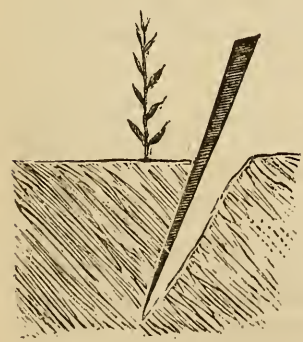
A



I presume, now, that I am talking to a farmer, who has from one hundred to five hundred acres of land; who has been raising cattle, horses, hogs, and sheep, for twelve years past; who has never planted a forest tree on his premises; who has stripped his cañons of the few straggling oaks which once kept up a flowing stream throughout the year; who has spent his money in purchasing fencing for his fields; whose homestead looks as dreary as weather beaten boards and ash colored surroundings can make it. I know that there are hundreds of such farmers around, and I wish to show them the money-making aspect of cultivating trees.

You have one hundred acres of ground then. That will be equivalent to a square plot of ten acres to each side, of two thousand and eighty-six feet; so that the outside of your farm will measure eight thousand three hundred and forty-four feet round. Subsoil a strip twenty-six feet wide round your land; this will take up five acres. Through this strip open four furrows six feet apart, and run the plow through each several times till the soil is loosened deep and finely pulverized. The ground is now prepared for planting.

B



Take a piece of thick twine or bale rope some two hundred feet long, untwist and tie through the strands short pieces of rag four feet apart; stretch the line tightly along the center of one of the furrows, and with a dibble make a hole six inches deep and an inch and a half in diameter opposite each mark on the line. Knock off one side of your box containing the plants, and with a trowel or strong knife carefully detach each tree from the soil, disturbing the soil about their roots as little as possible. Then take the tree between the thumb and finger of the left hand, pass its root into a hole to its natural depth, and with a trowel or piece of flat, hard wood pointed at the end, press the dirt around the root, and level the soil about it. In short, plant them just as you would cabbages or tomato plants; but mark this point, be *sure* that the roots are vertical. See this representation—figure A. The tree is in the hole with the stick ready to close in the soil about the root; figure B, the tree as planted with the stick ready to withdraw from the soil. You will thus have four rows of trees round your farm, four feet apart in the row,

and the rows six feet distant; each row will contain two thousand and eighty-six trees, making an aggregate of eight thousand three hundred and forty-four trees, occupying five acres of your ground. Two men can plant three thousand trees in a day in this manner. They will require no stakes. They must be dressed by the cultivator three times during the first year, and they must receive one plowing and three dressings each succeeding year, for four years.

The following table will give the dimensions of the trees at five years old, and at every succeeding year, till they are thirteen years old:

Age, years.	Diameter, inches.	Height, feet.	Wood in cubic feet.
5	9	40	5.75
6	10	45	8
7	11	50	11.5
8	12	55	14.33
9	13	60	18.40
10	14	65	23
11	15	70	28
12	16	75	34.75
13	17	80	42

On the sixth year, take out every other tree of first row; seventh year, second row; eighth year, third row; ninth year, fourth row. The amount of cord wood obtained each year will be forty-seven, fifty-seven, ninety-three, and one hundred and sixteen, making a total of three hundred and twenty-three cords. You will now have left four thousand one hundred and seventy-two trees, and the trees will be eight feet apart in the row. On the tenth, eleventh, twelfth, and thirteenth year take out every other tree, and the amount of cord wood obtained will be seventy-five, ninety-three, one hundred and fourteen, and one hundred and forty, making four hundred and twenty-two cords. Making an aggregate of seven hundred and forty-five cords of wood obtained, and a balance of two thousand and eighty-six trees, which will contain six hundred and eighty-four cords. Now sum up the whole operation. Total quantity of wood realized at the end of thirteen years, one thousand four hundred and twenty nine cords, at a cost of:

Seed	$5 00
Preparing five acres of ground	15 00
Six days' labor planting	12 00
Subsequent cultivation	60 00
Total cost	$92 00

These estimates are within bounds. On dry hillsides, the growth will not be so rapid, and if fifty per cent be taken from the foregoing results, there will still be left a wide margin for profit. On the other hand, on larger farms, a much greater number of trees may be thus cultivated. The outside capacity of one hundred and sixty acres will be fourteen thousand trees, yielding at the end of thirteen years, two thousand four hundred cords of wood. Any other kinds of forest trees will prove remunerative if cultivated, but on account of the rapid growth of the

eucalyptus and the density and durability of its wood, it commends itself over other kinds for immediate profits. But some farmers must bear in mind one cardinal fact: that while Providence furnishes the material and conditions for the healthy growth and development of trees, it does not engage in the cultivation of the soil.

CONSUMPTION.

But the plantation of trees is not the only process for arresting or mitigating the prevalence of fevers and other diseases resulting from the toxic effects of malaria. I say other diseases, because the action of malaria is by no means confined to intermitting, or typhoid, or other acute zymotic affections. The effect may not be to produce actual disease, but day by day it insidiously degenerates the vital force, and not infrequently superinduces that depraved condition of the body which is marked by tubercular deposit in the lungs. The most striking evidence in this matter is furnished in Holland, as is shown by the reports of Dutch and Belgian physicians, as well as by the latest observations in Algiers. According to the high authority of Dr. H. Von Ziemssen, tuberculosis, and the phthisis, resulting from cheesy pneumonia, are very frequent diseases in the fever districts of Holland and Amsterdam, and especially in the "polders" of Holland—those portions of land reclaimed from the sea by the building of dykes. These pulmonary affections are often associated with repeated attacks of intermittent fever, followed by the malarial cachexia.

In the last Biennial Report of the State Board of Health, the mortality by consumption is shown to be from two and one half to twenty per cent of the deaths from all other causes. A further examination shows the distribution of these deaths to be very unequal in the various towns reported, the mortality by consumption in some of them being greatly in excess of that found in others of equal size, and of equally stationary population, representing all ages. Doubtless a large proportion of these deaths is attributable to the number of the phthisical, who seek too late the benign influence of our climate, and thus add to the sum of mortality, by consumption, in the locality where they die. This is particularly the case in Santa Barbara, where consumption was comparatively unknown before the town became the sanitarium it now is. But making every allowance for the fluctuating character of our population, and the hopeless condition of many of the immigrants, the mortality by consumption is still greatly in excess of what we might expect it should be, especially in such localities as the region of the Russian River, Napa, Sonoma, and Petaluma Valleys, and that portion of the Sacramento Valley embraced in Yolo and Solano Counties, the southern part of the San Francisco peninsula, the San José and San Joaquin Valleys, and the coast region between Los Angeles and Santa Cruz, where the rate of mortality by consumption is between fourteen to twenty per cent. From a careful comparison of statistics furnished by physicians in all parts of Massachusetts, Dr. Bowditch has inferred the influence of a *damp location* in inducing, or at least promoting, consumption, and the influence of the same cause in giving rise to rheumatism, sore throat, and other inflammatory affections, is well known by all physicians. Our statistics, as far as they go, are confirmatory of the same conclusions.

Most of our towns have been located accidentally to meet the exigencies of trade, and without a thought as to sanatory advan-

tages. So also with our farming settlements. I have sought information from medical correspondents, chiefly by propounding queries relating to the causes of malaria, and find that the considerations, which determined their site, were convenient access to water, rivers, or roads. Whether the soil and surroundings are fit for a healthful residence is a secondary question. High situations are apt to be avoided, because too windy, and low ground preferred because more accessible, and because springs are more common here, and wells more easily dug. Hence farm settlements are often placed in the immediate vicinity of wet meadow land, scarcely above the water-line; or else on the springy soil which is frequently found at the foot of a hill; or else on the "hard-pan," which, at all levels, crops out here and there between strata of gravel, and which, by holding the surface water, is always wet and cold. It is not more difficult, therefore, to discover the causes of consumption in such surroundings than it is to explain the relative prevalence of the same disease in certain localities in the coast region already mentioned, where, owing to the damp and chilling oceanic winds during Summer, as well as Winter, the maximum mortality is found. Common sense, therefore, naturally suggests *drainage of soil and sewerage*, which is the other means above referred to as best calculated for arresting, not only malarial diseases, but also consumption. And it is a singular confirmation of the value and importance of this simple hygienic measure, resulting from observation and comparison exclusively, and without any preconceived ideas, that the English physicians, while entirely ignorant of the discoveries of Dr. Bowditch, arrived at the same conclusions. In eighteen hundred and sixty-five–sixty-six, inquiries were made in England, under Government authority, into the effect of certain sanitary works and regulations designed to promote the public health. In pursuance of this inquiry, twenty-four towns were selected in which improved drainage had been established. It appeared, that while the death-rate had greatly diminished, it was most strikingly evident in the smaller number of deaths from consumption. In commenting upon this fact, the chief medical officer reports, that "the novel and most important conclusion suggests itself, that the drying of soil, which has, in most cases, accompanied the laying of main sewers in the improved towns, has led to the diminution, more or less considerable, of phthisis."

As I have proceeded in writing this paper, the subject has so grown upon my hands that I have barely alluded to many important points, such as drainage of soil and sewerage, which will receive due attention in the next biennial report of the State Board of Health. Thanking you for your patient attention I must now close, merely expressing the hope that what I have said will be seriously considered.

[As no criticism adverse to the views advanced has been received since the reading of the above paper, it is fairly presumable that it is in general accordance with the opinions entertained by the medical gentlemen to whom it was presented for indorsement.]—Secretary State Board of Health.

ON FOREST CULTURE AS A PROPHYLACTIC TO MIASMATIC DISEASES.

By W. P. GIBBONS, M. D.

[Read before the Alameda Medical Association, May 3d, 1875.]

It has not been proved, though asserted until belief is established, that the aroma of the eucalyptus is effective in preventing the incubation of intermittents. The exceeding rapid growth of the tree is dependent on the quantity of water which is accessible to its roots. The proverbially unhealthy atmosphere of swamp land is due to stagnant water. Where currents are established by drainage or by excess of water, the cause of malarious fevers, if not entirely removed, is materially abated; it would be removed if the drainage were complete. Let us look at the results which naturally follow the planting and cultivation of some kinds of forest trees. In eight years the eucalyptus will attain a diameter of eighteen inches and a height of fifty feet. Experiments which I have made determine these facts: A branch of this tree which contains one hundred and five square inches of leaf-surface, will absorb 3.25 ounces of water in eighteen hours. The entire tree will furnish an area of three hundred and ten thousand five hundred square inches of leaf-surface, and the amount of water daily absorbed by the roots would equal six hundred and nine pounds, or seventy-six gallons. Given a stagnant swamp of two hundred acres, each acre having two hundred trees, and the amount of water daily absorbed by the roots would be three million and forty thousand gallons, or four hundred and five thousand three hundred and thirty-three cubic feet. This would be equal to a constant stream, running at the rate of three miles per hour, of two feet wide and six inches deep.

This question has a practical import, as applied to two projects which are now being discussed, and to the results on public health which would follow the adoption of either; the irrigation of the San Joaquin Valley, and the introduction of the water of Lake Tulare into San Francisco for economical purposes. The direct effect of irrigating the low lands of the valley would be the formation of a larger area within which malarial fever would prevail; for it is well known that there are lands along the San Joaquin, the Merced, and some of their tributaries, dry during the Summer months, but which, on being plowed, liberate the subtle poison which engenders disease. Farmers, without exception, have experienced this, in having every member of the family prostrated with intermittents. Physicians are cognizant of many places where the upturning of dry meadow soil, for agricultural purposes, has been followed by malarial fever. During the construction of the Central Pacific Railroad along the San Joaquin Valley, nearly every laborer became a victim of the same disease. The great district in California which is subject to malarial fevers includes large portions of the Sacramento, the San Joaquin, and the Tulare Valleys, extending from the

sixth standard north from Mount Diablo base to the eighth standard south, covering an area of three hundred and seventy-five miles in length, with a width varying from two to twenty-five miles. Much of this low land is known as tule swamp, from its being covered with *Scirpus lacustris* L., which grows in places from eight to twelve feet high. Other portions have a dense undergrowth of willow, which disappears in the neighborhood of the tules, but which reasserts its claim to the watery soil in places along the whole course of the valley. Outside the willows and the swamp, is a sandy alluvium, which comprises the arable portion of the soil.

This immense field of swamp and overflowed land, covering an area of over six thousand square miles, has comparatively little population outside of Sacramento, Stockton, Marysville, and other cities, which are feeders to the agricultural and mining population. Hence, it is difficult to estimate the area which may properly be regarded as malarial.

Will extensive irrigation change the climatal condition of a district of country? The question has been practically answered in the mining districts of California and elsewhere. Before the formation of ditches and the damming of the upper waters of rivers which form tributaries of the Sacramento and San Joaquin, the surface moisture of land among the mountain foothills was generally evaporated by the middle of May or the first of June. At this time clouds ceased to form in the upper air, and by day and night the unbroken clearness of the sky during the Summer solstice permitted the full intensity of solar heat to impinge on the denuded soil. The heat thus acquired during the day was seldom radiated with sufficient rapidity in the night to bring the temperature of the air within range of the dew point. In fact, during the latter part of Summer, the air was almost absolutely dry. The absence of dew thus became a marked feature of the interior climate.

After the headwaters of the rivers had been dammed, and ditches to the extent of seven thousand miles constructed, which spread water during most of the Summer through thousands of smaller channels, the air became so charged with vapor that deposits of dew became the rule instead of the exception. No other change was manifest except a slight reduction of temperature as a sequence of evaporation. Beyond the results thus foreshadowed in mining operations, and the certainty of securing fair crops, there is nothing to be urged in favor of extensive irrigation as compensatory to giving greater activity and diffusion to malarial poisons.

The matter of cultivating forests becomes then a question of almost vital importance to every settler within the precincts of this low land. It is not a doubtful experiment as a hygienic measure. The medical faculty need not be reminded of the conditions which increase the virulence of, or which destroy malarial poisons. Observation has established as facts: that excess of water in soil, by producing currents which carry off the poison or dilute it to the extent of rendering it obnoxious, prevents the formation of miasma; and that a lack of water in soil, by abstracting a necessary factor to vegetable decomposition, also prevents the development of disease. It is between these extremes that the forces operate which render active the toxic properties of marsh miasm. There must be added, however, a temperature ranging upward from sixty degrees Fahrenheit, and prolonged for weeks or months, before all the conditions which are necessary to produce vegetable decomposition and miasm are fairly established.

What then is the modus operandi by which forests purify the atmos-

phere and prevent the formation of marsh miasm? It has been stated that six thousand square miles of the great valley are included in overflowed lands, and this amount may be reclaimed. (1) Let us so enlarge the experiment detailed on a previous page as to make a belt of eucalyptus trees two miles wide, and extend it three hundred and seventy-five miles, or the entire length of the valley. Nature works by small accretions, but operates on a large scale. She would of herself execute all the work which is here laid out, were she allowed a little time. But the aggressive spirit of Yankeeism must accomplish tremendous results within a few years of business life. It cannot tolerate the idea of using up a few centuries out of the storehouse of eternity, in order that a piece of swamp land or a section of arid debris should be converted into a spot befitting fifty bushels of wheat to the acre. Fortunately for science, this spirit was not "peeking" round in the palæozoic age, as all transitions between the awkward Silurian and the post-tertiary eras would have been totally ignored.

A forest of the before-named magnitude would contain ninety-six million trees, and during every twenty-four hours there would be exhaled seven billion two hundred and ninety-six million gallons, or nine hundred and eighty million cubic feet of water. This would be sufficient to fill a ditch fifty feet wide, nine and five tenths feet deep, and three hundred and seventy-five miles long, which, flowing from each extremity of the valley to its outlet in San Pablo Bay at the rate of three miles per hour, would require two days to empty itself. The water taken up and exhaled by such a mass of trees would be equivalent to a constant stream of this volume.

This estimate represents the capability of daily absorption. The quantity of water which would actually be thus taken from the soil may fall far short of this amount, for the ground, not being always saturated, would afford but a limited supply to the roots. The range in quantity between fact and theory will not affect the argument, inasmuch as there is always maintained, in living organizations, a definite, yet varying degree of activity between the functions of the system and its consumption of food.

But absorption of water, and its subsequent exhalation, do not constitute the process of nutrition and growth in the vegetable world. The water of the soil not merely holds in solution all the solid mineral matter which goes to make up the substance of the tree, but gaseous elements, either in a simple form, as of atmospheric air; or combined, as in carbonic acid, sulphureted hydrogen, and other mephitic gases. Whatever there may be held in solution is, in a general sense, absorbed by the roots and conveyed, with little or no change, to the leaves, which form the laboratory of the vegetable world. Carbon, hydrogen, lime, potassa, soda, and other substances, are here subjected to changes, by the agency of solar light and heat, which adapt them to the composition and the structure of the tree. This chemical activity is rapid in many growths, especially in the eucalyptus. The strong aroma of its gum is diffused to a distance of thirty or forty feet. The hydrogen, which forms one of its elementary constituents, is derived from the decomposition of water which the tree takes from the soil. The entire

(1) Land Office Report, 1868.

process of vegetable life constantly carried on in effecting the assimilation of food, not only returns to the atmosphere oxygen, as a product of the decomposition of water and carbonic acid, but restores the purity of all other substances that are exhaled either in a simple or compound form. Thus, in whatever shape marsh miasm may exist—whether held in solution by water and diffused in the vapor of night, or retained in the soil and liberated by the presence of water—it is certain to be destroyed by an adequate development of forest growth. This is so fully recognized in medical literature as to render exemplifications unnecessary.

As another sequence of the activity of vegetable growth, the cooling of the atmosphere is prominent. This reduction of temperature is mainly due to exhalation of water from the leaves. This function is most active during the day; for the more rapid the evaporation the cooler does the air become; consequently, the greatest difference of temperature between the open air and the shade of a tree is from noon until three o'clock P. M. This range, being affected by local causes, cannot be precisely and uniformly indicated, except by actual experiment. Where the thermometer stands in the shade at 85° Fahrenheit, it will be at 100° in the sunlit air, protected from direct solar rays; at the same time the surface soil will indicate 115°. This is the breathing temperature prevalent for parts of several months along the great valley of which we have spoken. At times 130° or 140° is indicated by the thermometer. It is very common for the night temperature to stand at 80° or upward. At such times the incubation of disease is active.

Unless the conditions be peculiar, a maximum temperature of 80° through the day will be followed by a minimum temperature below 60° during the night. Along seashore counties the thermal range is not so great, and in valleys protected from ocean breezes the radiant heat during night arrests the cooling process from inflowing air.

Let us see what disposition would be made of the vast amount of liquid daily absorbed and discharged into the atmosphere. At 212° a cubic foot of water will be converted into one thousand six hundred and ninety-six cubic feet of vapor. At 60°, with the barometer at thirty inches, each cubic foot of air will contain 6.22 grains of vapor. The nine hundred and eighty million cubic feet of water will saturate a belt of atmosphere three hundred and seventy-five miles long, ten miles wide, and one thousand two hundred feet in thickness, which would be resting over the valley for the greater portion of every twenty-four hours. But would the swamp land yield this quantity of water every day? Estimating the average rainfall at eighteen inches, and excluding the inflowing water from mountain streams, it would require over eight hundred days for the forest to absorb all the moisture that the valley received during the Winter months. If this process commenced with the active growth of vegetation in February, and were to continue but one hundred and twenty days, all the requirements of growing crops would be met, without appropriating over one sixth of the amount which fell upon the land. Moreover, there would be a compensating action constantly going on, in consequence of the vapor, rendered to the atmosphere, being partially returned to the soil by condensation.

The arid nature of parts of the San Joaquin Valley is not referable to high temperature and evaporation alone. In the middle of the plains, east of Stockton, excavation shows a succession of strata formed of washed bowlders and coarse gravel, more than seventy feet in depth,

before a retentive water-bearing bed is reached. Other parts of the valley show a similar formation, and evidence tends to the conclusion that the inland sea which once covered this area was obliterated by debris brought down from the mountains on either side. In fact, the process of denudation is still active, as may be seen along the entire course of the range. This deposit, being coarse and loosely packed, cannot retain the water which falls upon the surface. Such is the character of more than two million acres of this arid land.

It is not possible to define the distance which the roots of trees will travel, under favorable circumstances, in quest of water. Some years ago, in the process of grading Clay street, San Francisco, excavation was made through a sand-bank to the depth of thirty feet. A small scrub-oak, four inches in diameter, was growing on the crest of the hill, on the line of the cut. I traced its main root thirty feet in a vertical line, and at that depth it was still half an inch in diameter. East of Alameda there is a hillside cut, which gave origin some years ago to a small landslide, exposing the root of an oak tree. When I observed this for the first time, there was a small root-fibre, which looked like a piece of half-inch rope, stretched horizontally for a distance of nearly forty feet, without any apparent diminution in thickness. At the present time it is over three inches in diameter, and its distal extremity is doubtless over one hundred feet from the trunk. Thus it is that the terminal roots of trees, through which absorption takes place, will follow, horizontally or downward, the receding line of moisture to an extent that is determined by the texture of the soil. Roots, like branches, are always throwing out side-buds, which sometimes increase in number to a marvelous extent. There is a well in Alameda four feet in diameter, which was almost filled with the roots of a sycamore tree that grew within a rod of it. There is another well in the yard of the Congregational Church, in Oakland, from which was taken a solid mat of roots, none larger than a thick knitting-needle; the whole about three feet in diameter and two feet in thickness. These cases, among many, are sufficient to show the extent of root development in the presence of a copious supply of water. They also show the rapidity with which organic matter can be supplied to the soil from this source; and, furthermore, the modus operandi whereby a loose, coarse deposit of purely mineral matter has its interstitial spaces supplied with vegetable mold, and is thus converted into productive soil.

These secondary results of forest-planting land, while being carried on far beneath the surface, are supplemented by processes of trunk growth. Everybody is familiar with the fact that under an old tree there is always from six to twelve inches of vegetable mold, derived from the decomposition of leaves and bark which are annually shed. The weight of dried matter thus furnished by a tree of the size indicated on a preceding page, will not fall short of two hundred pounds. A considerable portion of this is composed of organic matter, some of which may be resolved by subsequent oxidation. The balance constitutes the potassa, lime, silex, and other minerals, which, held in solution by the water of the soil, have been taken up by the sap, conveyed to the leaves, metamorphosed into the solid material of the tree, and partly returned to the earth through the leaves and bark. The results of this process, on a large scale, and during consecutive years, may be seen in any forest-growth which originated on a bed of gravel. Fine mold fills the interstices between washed or angular pebbles, furnishing sustenance to a dense undergrowth of shrubs and succulent plants. Time was

when such localities were as unpromising to vegetation as any which now compose our Californian valleys.

It may be said that this theory proves too much; that if trees take up so much water from the soil, the surface ground must necessarily be desiccated, and thus rendered unfit for cereal crops. This does not follow. While it is admitted that during the growing season the soil beneath forest trees may contain a proportion of water smaller than that without their range, it is also true that a large portion of the San Joaquin Valley, having a known depth of seventy or one hundred feet, being the product of denudation and not retaining the rainfall of Winter near the surface, is capable of sustaining a sparse vegetation only so long as frequent rains keep the substratum in a moist condition; consequently, the forest would obtain its main supply of water by the trees projecting their roots downward far beyond the limits of surface moisture. But our argument is now directed primarily to a hygienic point, and secondarily to the means whereby unproductive land may be brought to a condition in which crops may be insured at a minimum expense and at the greatest profit to the cultivator. In a future paper I will resume this subject, and endeavor to prove that forest trees return to the land and air more moisture than they extract from surface soil.

The conclusions apparent from the facts and arguments herein advanced are the following: that forest trees in sufficient number will absorb, from deep as well as from superficial strata, a sufficient quantity of water to establish regular subterranean currents, and that whatever miasm may be combined with or held in solution by the water will thus be carried off, or have its toxic properties in whole or in part neutralized; that the water thus exaled will be diffused through the atmosphere in such quantity as to be returned in great part to the surface soil by precipitation; that the high Summer temperature may thus be so modified as to reduce the nocturnal heat below sixty degrees; that the causes thus operating to prevent vegetable fermentation, or to dissipate miasm if developed, would protect the valley from regular visitations of paludal fevers; that the modification of climate thus induced would, under ordinary circumstances, insure average crops of grain in localities which are now dependent either on unusually wet seasons or on artificial irrigation; and that, while immediate benefits would thus be conferred upon the farmer by extensive tree planting, the remuneration would be cumulative, not only in the regularly increasing value of his timber, but in the prospective reclamation, by natural processes without absolute expense, of land which is now utterly useless.

From the foregoing remarks it may not be inferred that the writer denies any prophylactic agency to the aroma of trees; their reputed virtue in this respect cannot be either entirely ignored or satisfactorily proved. On a speculative basis, there are many arguments in favor of the theory; from a strictly scientific point of view, much investigation will be required before adequate testimony will be accumulated to raise it above a popular belief. The object of this paper has been to bring known principles of vegetable physiology into relation with some of the causes which originate certain forms of disease.

DRAINAGE OF BUILDING SITES—SUBSOIL AND HOUSE DRAINAGE, ETC.

By THOMAS M. LOGAN, M. D., Secretary State Board of Health.

In the following remarks I shall avail myself of the valuable contribution to "Sanitary Engineering," by Baldwin Latham, C. E., London, and also the elaborate work on "Farm Drainage," by Henry F. French, of Concord; the principles and processes applied in the one instance being equally applicable to the other.

In all works of sewerage, in order to get their full benefit it is requisite that provision should be made for the drainage of the subsoil. The mere fact of carrying out a system of sewerage, and being obliged to cut through various strata of a more or less retentive character, is naturally a means of securing, to a great extent, subsoil drainage. But it is not well to depend entirely upon the intersection of various geological formations; for it has been shown that drainage-works, when first brought into operation, or during their construction, have had greater effect in drying the subsoil, and in reducing the death-rate by phthisis, than has been secured in after years. This may be accounted for from the fact that the drainage of the subsoil was more perfect prior to the complete consolidation of the sewer trenches than it has been subsequently. In designing a system of sewers, therefore, the engineer should make provision, more especially in retentive geological formations, for the effectual drainage of the subsoil, the works for which purpose should be constructed and carried out so as to prevent any chance of sewer water percolating into the surrounding ground. This part of the subject belongs more properly to the sewerage of cities.

At present, we wish to confine our attention to the drainage of farms and country seats. It is well known that a soil perfectly saturated with water, which can only part with its water by evaporation, is rendered cold and unwholesome as a site for human dwellings; for all impurities that enter the soil accumulate. Soils which are naturally porous, from which rain rapidly disappears, are known to be the healthiest situations for the sites of houses. It has been clearly shown from experiments, that the effect of drainage upon ordinary agricultural land is to render it less capable of conveying extremes of temperature. Undrained fields are sooner affected by the lower temperature of Winter, or by sudden showers of rain or snow, than fields of the same class that are drained. The object, therefore, in view, is, at the least cost, to relieve the soil of surplus water, or water that is not held by attraction, or, in plainer terms, water that will run out of the soil. Ordinary soil, thoroughly dried, will receive about half its bulk of water before any drains off, so that one and one half feet of such soil may hold by attraction half our

annual rainfall, which is twenty inches. Much land, hard and firm, which is covered with water forming ponds and pools during the rainy season, although apparently dry during the Summer, is yet often filled nearly to the surface with *stagnant* water, which cannot percolate through the hard pan flooring. Such land, as well as all land in which water is found at any season within three to four feet of the surface, needs draining for health. Land in which water will be found at a depth of two feet in any part of the growing season, needs draining for agriculture. How is this to be effected?

To drain a tract, large or small, one acre or ten thousand acres, find an outlet low enough to give the necessary fall. One foot in one hundred is sufficient—in fact, a quarter of that fall sometimes answers. If the fall be slight, greater care will be necessary in laying out the work and performing it. Common drain tiles are recommended, rather than stones or wood, and the directions given are especially adapted to the use of tiles. They are usually about twelve inches long. If the four-inch are not large enough, two or more lines of them abreast may be laid. Miles of drains have been laid with a conduit no larger than a single four-inch pipe. The work should be all laid out before breaking ground, and in general a day's service of a competent engineer, to lay out the work and fix the grades, will be worth far more than it costs. Usually, a single drain should run through the lowest part of the tract, and it is not important that the main should be straight. Having laid out the main, lay side drains running into it, having in view two principles: first, to run each drain up and down the slope of the land rather than across; and, second, to have them parallel to each other. The depth should be four feet or more, and the distance apart, with this depth, may be from thirty to fifty feet. In any soil, except a close clay, fifty feet apart will be a safe distance.

To open them, begin at the outlet, so that the water may run off as the work proceeds; and with a common spade, and a pick if necessary, cut a trench, by a line, eighteen inches wide at the surface, narrowing to four inches, or the width of a laborer's boot, at the bottom. Having opened all the drains, keeping the main low enough to let off the water, then lay the tiles at the upper end. If there is much fall, and there is danger that the main, or lower end of it, may cave in, it may be only partially excavated at first—just enough so that the water may run off from above. Lay the first tile, usually of two inch size, with a brick or flat stone over the upper end to close it entirely, and the next, end to end, with it, and so on to the main, keeping always an inclination, however slight; for if any depression is made the silt will lodge in it and obstruct the work. In this system of drainage no water is to be anywhere admitted, except by percolation through the soil. There must be no opening to the surface, or into any ditch, or to receive sink-water, or anything but clear water, creeping underground, which gets in chiefly at the joints. Nothing short of cementing the joints can keep the water out. The great difficulty is to keep out silt or fine sand. Having laid two or three tiles on the bare earth, cover each joint half or more round the tiles with a piece of tarred paper, as large as a common letter envelope, and, holding the whole firmly, place soil or gravel over it and on both sides of the tiles, pressing it enough to keep them in place. Cover and fill up with anything at hand, except soft clay or fine sand, which should not be placed in contact with the

tiles. When approaching the junction of the minor drain with the main a curve should be made, so as not to bring in the side-stream at right angles. The capacity of pipes with round bores is nearly in proportion to the squares of their diameter. The square of two is four, and the square of four is sixteen; so that a four-inch pipe theoretically carries four times as much as a two-inch pipe, and actually carries more—the friction being less in proportion in large pipes. Again, water running down hill, in a smooth pipe, gains by accelerated velocity—as any falling body does—and the stream grows smaller as it flows swifter, and so requires less space to carry it. If, however, a pipe be running full, this acceleration is retarded, because the stream cannot lessen its bulk without leaving a vacuum. The admission of side-streams fills this vacuum, and thus allows the main stream to run faster. With considerable fall the main pipe may, in fact, be much smaller than would seem possible with reference to these principles. In one case, in England, it was found, by actual experiment, that the addition of eight junctions, each of three inches diameter, into a main line of pipe of only four inches diameter, so increased the velocity of the stream that there was no increase of its sectional area. Having thus connected the drains in one system, with only one outlet, this should be secured by a wire grating, and have a clear fall of a few inches, upon a flat stone, that it may not be obstructed by back-water and mud. I have been thus particular in making an abstract of the instructions, already referred to, how to drain a field or building lot, because the same rules are applicable to the drainage of buildings. Another, but less practicable mode of drainage, because stone cannot be always procured without much expense, is that of which an example was made on the grounds of the San Francisco Almshouse. On the northeast corner of the tract was a little swamp, probably about three and a half acres. This marsh was kept moist and damp by springs of water, and proved the source of miasmatic exhalations. This land was reclaimed by causing a number of ditches to be dug, about six feet apart, and deep enough to get down to a solid foundation. Stone was then hauled from a neighboring quarry, and placed in a layer, one foot deep, and then covered over with sod. The ditch was now filled up with soil, forming what is known as the "blind drain." The inmates of this institution are no longer plagued by malarial affections, while the reclaimed land more than supplies the house with vegetables.

HOUSE DRAINAGE—SINKS AND WATER-CLOSETS.

We have thus far been dealing only with clear water, to be conveyed in pipes, that may take in or let out water at every foot. Such drainage is entirely distinct from the drainage of sinks and the like, which requires pipes much larger and smoother, and also close-jointed. As a rule, the works of house drainage are carelessly and thoughtlessly carried out, and often inflict untold injury on the luckless occupants of the house in which they are executed.

It appears that there is no fluid so hard to carry away as that of sinks and water-closets. The soap, grease, and other matters are deposited on the sides of the pipe, and it may be said to be a mere question of time, depending on the size of the pipe and the flushing of water, how soon it will fill up. This is why the drainage of clear water should be kept distinct from that of cesspools and sinks. The following method

is reported as having been in successful use for five years, with a fall of only about one in a hundred: At the sink is a common bell trap; a lead pipe, of one-and-a-half or two-inch bore, runs down and out through the cellar or ground into a reservoir, which should be of well-cemented hard brick, and should be a foot or more below the surface. The lead pipe should discharge under water; and so we have a second trap, that prevents any air passing up the pipe. The outlet pipe, starting about one third up from the bottom, may be of lead, one-half to two inch bore, and should run upward and out of the reservoir at about a third from the top, and into a large pipe of stone or iron. Thus the water enters the lead pipe about midway from top to bottom, leaving the greasy particles floating on the top and the heavy particles at the bottom, so that what runs off is comparatively clear. It still carries off a great deal of soap, and will deposit it for a long distance. The final deposit, or cesspool into which sinks and water-closets are discharged, should be placed, if possible, below the level of the water in the wells at their lowest, and always on the down-stream side of the well, as the water is supposed to flow in the ground. A large vault may be supplied with a quantity of dry soil, and the moisture may be thus absorbed; or a trap may be there arranged, which shall separate the fluid, which may be pumped out and applied to the soil; or the moisture may be absorbed by the earth, if the conditions are such as to render it safe.

A judicious application of the principles I have thus collated, will enable any one of ordinary common sense to take the precautions essential to health, so far as relates to house drainage.

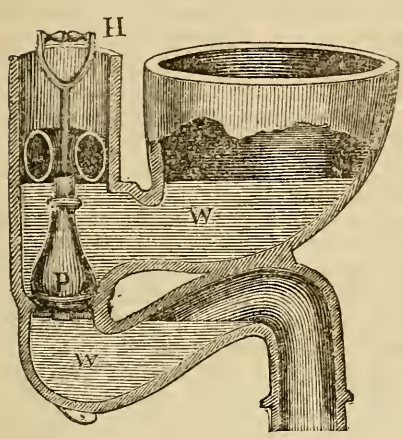
WATER-CLOSETS.

The requirements of a good water-closet are, that it shall be inodorous, shall work efficiently with a minimum quantity of water, and shall be simple in construction and not liable to get out of order. There can be no doubt that many water-closets which are now in use are extremely defective in the principle of construction, and when introduced into a house, instead of being a comfort and luxury are a positive nuisance, and often endanger the health of its inmates. Most of the complaints which have been raised against the water-carriage system have been directed almost solely against water closets, as being the source of nuisance, when introduced within a house. These complaints have in many instances been well founded; and the remedy is, not to abandon the water-carriage system, but to correct the defects which have given rise to these complaints. A good water closet is the only appliance fit to be used within a house, for by it all matters are at once conveyed away, and cease to have the power of producing evil, so far as our houses are concerned. It is not so, however, with those systems that conserve fæcal deposits within or in close proximity to our dwellings, as there is always danger in storing a dangerous article, however carefully we may tend and guard against its evil effects. It is found in practice that some of the simplest and cheapest water-closets are the best; in fact, all those closets consisting of a simple basin and trap, usually called the Hopper closet, if provided with ample water for flushing, can be used without causing any nuisance, as there is no space for noisome gas to accumulate, and no exposed area, plastered with fæcal deposit, to generate foul gas. If the closet is provided with

ample ventilation,(1) no gases can pass back through the trap to cause any mischief.

Many of the Hopper closets in use, owing to defects in the construction of the trap, and from the inadequacy of the flush of water, do not clear themselves at every discharge of the closet. The consequence is that fæcal matter is left in the trap, and its exposure often gives off a bad odor. Those who require a still more perfect closet than the simple basin and trap, will find Jennings' closet a perfect sanitary appliance. It consists of a basin and trap made in one piece of earthenware, but instead of the small quantity of water usually supplying the trap of a Hopper closet, in this case a hollow plug (P), is used to dam up the water in the basin. The consequence is that the fæcal matter is at once dropped into a large volume of water (W), and to a certain extent it is immediately deodorized, as those peculiar organic odors given off by fresh fæcal matter are prevented from escaping; and when the handle (H), which lifts the plug, is raised, everything in the basin is suddenly discharged into the trap below, and so into the drain. The hollow plug also serves as an overflow, if the basin fills too high.

JENNINGS' WATER CLOSET.



URINALS.

As a matter of convenience, and as a preventive of nuisance being committed in places out of proper sanatory control, public urinals become a necessity in all urban districts. They are also required in houses, manufactories, and other places, where proper consideration and cleanliness is a matter of vital importance. A urinal, not properly attended to, soon becomes a disgusting nuisance, as urine very rapidly undergoes decomposition, and when in this state it has the power of rapidly turning fresh urine into the same state; hence the necessity of thoroughly cleansing and washing every part of a urinal. As a manure urine is by far the most valuable part of town sewage. Compared with solid fæcal discharges, the value of urine is as six to one; therefore, every effort should be made to secure the urine produced in a rural district for agricultural purposes. In some manufacturing towns urine is

(1) This may be effected by carrying up the soil pipe to the roof, or some other convenient point, care being taken that no windows, house ventilators, or the flue of a chimney shall be near the point of termination, as at times there are in-currents into the house at these points. If it is necessary to carry the soil pipe up to the ridge, the pipes for this purpose may either be carried inside or outside the roof; but in all cases it is better and safer to place both the soil pipe and all other pipes, in connection with the drains, outside the house. The same provisions should be made for the ventilation of urinals, general details of which will soon be considered.

regularly bought and collected in lant-carts for use in fulling of woolen cloths.

A great variety of forms of urinals have been introduced at different times, and have now become articles of common manufacture. They are usually made of glazed earthenware, and sometimes of common stoneware. In the distribution of water to a urinal, care must be taken that every part of the urinal is properly washed. The volume of water required varies greatly with the description of urinal. In those cases in which the urine is discharged into a trough, and the water merely used as a diluent to assist in washing away the urine, the volume of water required is small; but in cases in which stalls are used, and a constant supply is provided, this supply is often equal to half a gallon per minute. The water in basin-urinals is distributed by a flushing rim, and in stall-urinals, either from a perforated pipe or a spreader made specially for the purpose.

Urinals are generally trapped with the ordinary siphon trap, and provision should be made for the ventilation of the drains communicating with a urinal; especially in cases in which they are constructed inside houses. The best mode of ventilating urinals is to carry up the drain-pipe in the same way as the soil pipe of a water-closet is treated. In many cities of Europe, the provision of public urinals has had a fair share of consideration, but it is to be regretted that this sanatory measure is so little regarded in America. The same remarks apply to public latrines. Accommodation of this class, as a rule, is only provided at the various railway stations or hotels; but even here, they are neither as convenient, or as well attended to as they should be, and the roving public have to suffer, in consequence, much serious inconvenience, and sometimes serious injury to health. All public as well as private urinals and latrines should be so constructed that while they are sufficiently screened from public view, they should be readily accessible, and nothing repulsive to privacy or decency be permitted.

THE DRY-EARTH METHOD OF TREATING REFUSE.

By SAMUEL LEAVITT, New York.

[Read before the New York Public Health Association, October 23d, 1873, and published in the "Sanitarium" for May, 1874.]

THE EARTH-CLOSET.

This system was introduced into Lancaster, England, by Mr. Garnett, of Guernmore Park.

In eighteen hundred and seventy, the earth arrangement was taken in hand by the corporation, its use having been demonstrated. In eighteen hundred and sixty-nine there were two hundred privies of this sort in Lancaster. The stools were not covered in detail, but Mr. Garnett's men supplied earth to the pits once a day. No slops entered those pits, and not all the urine; for besides the men's day urine, which here, as elsewhere, would commonly not go into the privies, Mr. Garnett had an arrangement which extended to one hundred and seventy out of four hundred and fifty families, by which the urine of chamber vessels was kept from the closets. It was collected in large vessels and removed daily. A shilling a quarter was paid to those who would thus keep their urine separate. (1) At first, the ashes of the town were mixed with earth, but ashes [Bituminous, S. L.] are now discarded, though the street sweepings are found available. The dried earth is broken up by a steam-turned roller, and is screened so that it is a dry brown powder when used. The report states, that as compared with water-closets, as usually kept in similar parts of towns, there is no question that greater cleanliness and less offense are attained by the earth-closets, in the poorer neighborhoods of Lancaster.

Again, the death registers show that few or none of the deaths from diarrhœa and typhoid have been in houses provided with earth-closets; and the medical men of the town agree in stating, that since their introduction, fever has almost wholly disappeared from parts of the town where it was formerly rife.

Dr. Buchanan thus sums up some of the

ADVANTAGES OF THE EARTH SYSTEM.

1. The earth-closet, intelligibly managed, furnishes a means of dis-

(1) I believe that the time will come when, even in the largest cities, a system of main and branch pipes will be laid for conducting urine to the wharves, where it will be received in barges containing tanks. It would not be such a difficult matter to take it away from each house in close vessels. This outgoing fluid would be worth much more to those who took it away, than is the milk which is brought into the city in such quantities.

posing of excrement without nuisance, and apparently without detriment to health.

2. In communities, the system requires to be managed by the authority of the place, and will pay at least the expenses of its management.

3. In the poorer class of houses, *where supervision of any closet arrangement is indispensable*, the adoption of the earth system offers especial advantages.

4. This system does not supersede the necessity for an independent means of removing slops, rain water, and soil water.

5. The system might be at once applied to any town of ten thousand inhabitants.

6. As compared with the water-closet, the earth-closet has these advantages: it is cheaper in original cost; it requires less repair; it is not injured by frost; it is not damaged by improper substances being thrown into it; and it greatly reduces the quantity of water required by each household.

7. The whole agricultural value of the excrement is retained.

In a paper read before the Glasgow Sewage Association, March thirtieth, eighteen hundred and sixty-eight, E. C. C. Stanford, F. C. S., says:

"Water is a mere carrier, and no disinfectant; its cost, also, from the great quantity required, is very considerable. The whole system of sewerage by water-carriage is extravagant. It carries the solid and liquid excreta down to our neighbors to rot at their doors, and leaves us a legacy of deadly gases, to remind us that our effort to cheat nature has signally failed. As applied to even ridding ourselves of the nuisance, it is the finest effort of the 'circumlocution office,' and the best illustration of how not to do it in our generation. Engineers have employed an elephant to do the work of a mouse, and the burly brute has trodden down and laid waste the country."

In another paper before the Glasgow Philosophical Society, Mr. Stanford says:

"Our authorities want, of course, some grand scheme, but they forget that the question is one of minute details. We are assailed by a large army of small nuisances—one at least to every house—and we must attack them one at a time. Attacked in their united strength, they will assuredly overcome us."

THE NEW SYSTEM IN AMERICA.

The introduction of the earth-closet into this country is largely due to the labors of George E. Waring, Jr., of Newport, who has written several books on the subject. He thus criticises the popular American system of treating human excrement:

"The water-closet is the chief thing of which women living in the country envy their city cousins the possession. In country houses, one of the first steps towards elegance is the erection of an expensive water-closet in the house, provided with a force pump that is doomed to break the back and the temper of the hired man; a tank and pipes, which are pretty sure to be burst by frost every Winter; the annual tax of the plumber's bill; and, worse than all, a receptacle in the garden known as a 'cesspool,' which usually has a private subterranean communication with the well from which drinking water is taken. The manure is, of course, lost; it is worse than lost. Too far below the surface to be of use to vegetation, it lies a festering mass, sending its foul and poisonous gases back through the soil pipe and the kitchen drain into the house, and

developing in its putrid fermentation the germs of typhoid fever and dysentery that any film of gravel in the lower soil may carry to the well or the spring. * * * Hence comes typhoid fever, *of which no single case ever occurred in a civilized community without the direct intervention of human agency.* * * * Out-of door privies, those temples of defame and graves of decency, that disfigure almost every country home in America, and raise their suggestive heads above the garden walks of elegant town houses, are, I believe, doomed to disappear from off the face of the earth."

Mr. Waring quotes as follows from Professor S. W. Johnson, of Yale College:

"The guanos and fish manures, which are brought from a distance or manufactured at a heavy cost for our market gardeners, are in reality paid for, not by them, but by those who purchase their produce in the city markets. The animal who stands at the head of creation requires the richest food, and yields to the food-producer the richest return. It requires but little art to convert *his excrement into increment*; the conversion may be made extremely profitable. The excreta of a man have been valued in Flanders at nine dollars per annum, and the Chinese agriculturist will give a day's work for ten gallons of urine."

Writing of the destruction of American soil, Mr. Waring says: "Fortunately it will not continue always. So long as there are virgin soils this side the Pacific, which our people can ravage at will, thoughtless earth robbers will move West and 'till' them. But the good time is coming when (as now in China and Japan) men must accept the fact that the soil is not a warehouse to be plundered, only a factory to be worked. The sewers of London wash into the sea the manurial products of three million people, to supply whom with food requires the importation of immenss quantities of grain and manure. The wheat market of one half the world is regulated by the demand in England. She draws food from the Black Sea and from California; she uses most of the guano of the Pacific islands; she even ransacks the battle-fields of Europe for human bones, from which to make fresh bones for her people; and in spite of all this her food is scarce and high, and bread riots break out in her towns."

Nearly all the earth-closets in use in this country are modifications of that of Rev. Mr. Moule. The prominent manufacturers are the Hartford Earth-Closet Company and the Wakefield Company. The latter have introduced a large number of their closets into Central Park. Mr. Waring says truly that, "besides the need of this system in smaller towns, there are portions of this city where something of the sort is absolutely necessary. The whole Harlem flat is so low and level, that it will be almost impossible to lay the sewers so high as not to be entered by salt water at high tide."

It has been demonstrated in England that street-sweepings are available for the earth-closet. I believe that it is entirely practicable to use this system for the whole city thus: Let there be a depot-shed in each ward or precinct, to which all the best and driest of the street-sweepings shall be brought and all the ashes. Let the carts dump their loads upon coarse screens, to remove all such refuse as tin and crockery. Let the dirt pass through rollers or stamp mills, and then through revolving screens; and when duly prepared be taken to the earth-closets, and thence to the country. When desired, it can pass several times through the closets. Thus, instead of an expensive removal of street dirt and

ashes and night-soil, the city can send these three "nuisances" away in the form of the most valuable known fertilizer.

It is probable that this business will prosper in small towns faster than in cities or isolated abodes. The latter will not take the trouble, and the cities will use water-closets until shamed out of the practice. But individuals will start Dry-Earth Companies in towns, as has been done in New Haven, and will soon so demonstrate the merits of the plan that the municipalities will adopt it. The lack of such companies furnishing earth and removing the product, has been the only obstacle to the rapid spread of this great reform. A United States Dry-Earth Company should be formed, which would put itself in communication with the coal dealers throughout the country, who have sheds, screens, and carts, and are in the habit of removing ashes. This company should induce the coal dealers to sell all the varieties of closets, furnish dry earth, and remove and sell the fertilizer; and they should be guaranteed a fair price for the condensed grades of the latter, at a central depot in New York, when neighboring farmers did not want it. Such an organization would cause the system to spread like wildfire.

The first apparatus patented in this country for such use of earth was the "Excelsior Sanitarian Cover" described below. The patent was dated in eighteen hundred and sixty-six. The first Moule commode was imported into this country in eighteen hundred and sixty-eight. The following testimonials will show the progress of the reform as represented by the Moule, Wakefield, Hartford, etc., closets:

"It is the best means of disposing of night-soil. It is particularly valuable in this city, and in all localities where similar [imperfect] conditions obtain with regard to drainage." J. H. Rauch, Sanitary Superintendent, Chicago.

"The system of earth-closets at Fort Adams, R. I., appears to have at length settled a question which for twenty years or more has been a source of perplexity, trouble, and expense." J. F. Head, Surgeon United States Army.

"From ten to twenty earth-closets have been in constant use upon the Brooklyn parks during the last year. We are introducing them in preference to water-closets, even where water supply is already secured and sewers laid." Olmstead, Vaux & Co., Landscape Architects and Superintendents.

One hundred Wakefield closets are now (eighteen hundred and seventy-three) in use in the Central Park, New York.

"As Chairman of the Committee from the Boston Board of Aldermen appointed to assist at the Jubilee Festival, I had occasion to observe the working of the earth-closets, and they appeared an entire success." E. A. White.

"This is one of the cheapest and most useful discoveries of modern times." Mass Board of Health.

"The most important sanitary discovery of the age." Wm. Lloyd Garrison.

"Whether regard be had to economy, health, or decency, the earth-closet is *facile princeps*." Howard Potter, of Brown Bros.

The following persons give similar testimony in favor of the system: Stephen Smith, M. D., New York Board of Health; R. W. Brady, S. J., President of College of Holy Cross, Worcester, Massachusetts; B. Evans, Superintendent State Reform School, Westboro, Massachusetts; L. D. Wilcoxson, M. D., Connecticut State Hospital; J. F. Whiting,

Mayor of Rahway, New Jersey; W. C. Chapin, Pacific Mills, Lawrence, Massachusetts. The principal Methodist Camp has ordered its universal use on its grounds.

THE EXCELSIOR SANITARY COMPANY

of New York, claim to have issued the first patent for earth closets in this country, viz: in eighteen hundred and sixty-six. However that may be, they have certainly developed some useful inventions. Their best addition to sanitary apparatus seems to be a hollow cover.

The invention consists of a hollow compartment in this lid or cover, for the reception of a suitable deodorizing compound, with openings in the under part, through which, when desired, by turning a handle, the preservative agent is thrown into the chamber-vessel—part before, and part after the vessel has been used, thus bringing the antidote in immediate contact with, and enabling it to overcome, the poison.

Something of this sort is certainly called for, besides the stationary earth-closets, for sick chambers, and many other places where regular closets cannot be used. It is acknowledged by all sanitarians that even the carrying of vessels which emit foul odors and poison the air, from the chamber of a patient to empty, is one of the most prolific sources of the spread of cholera. Through a series of complications, such as often befall patents, this useful invention is only now being put on the market. All physicians who have seen it are loud in its praise. It is peculiarly adapted to act as a pioneer in this line, because being so small it can be put away in any corner or closet, and kept full of earth ready for sickness, or a rainy day, or a day when the water-closet is broken or frozen. The recent addition of a galvanized iron receptacle—the size of a large slop jar—with a wooden privy-seat rim, makes it a complete earth-closet. J. G. Collins, Sing Sing Prison, said of this machine: "It is just what is wanted for all our prisons. I cheerfully recommend its introduction into each and every cell of each and every prison." Theodore Dimon, Physician of Auburn Prison, said: "The agent of our prison has determined to have one of your hollow covers attached to each night-pail in every cell of this prison. * * * This will enable us to keep them in use, without cleaning out, for say a week, or even longer. The evening march of the working convicts to the pail-ground would be saved, and much exposure to rain and sleet avoided." D. B. McNeil, Inspector of State Prisons, said: "I am satisfied, from experiments made here under my eye, that it is highly valuable and wholly indispensable for purifying the cells of all prisons."

THE GOUX SYSTEM FOR CITIES.

There are a few considerations that make the Goux system especially applicable to this city at present. Perhaps the most important of these is that the company introducing the process here are already running wagons carrying their peculiarly prepared tubs to and from the houses of customers. This does away with the principal obstacle to the use of all these machines. A description of the system will show what are its other advantages. M. Goux's invention reverses the earth-closet system by placing the great bulk of the disinfectant and disintegrating material in the receiving tub before it is used at all. A layer of any dry absorbent material (preferably earth, ashes, or peat, though sawdust, cut straw, and similar substances seem to answer nearly as well,) is placed over the

bottom to such a depth that when the mould, which is a close-covered kettle, is placed on it, the upper edge of the mould will be on a level with the upper edge of the tub. Additional absorbent matter is now packed round the mould, so that when it is withdrawn, the vessel, with its packing, shall present a receptacle in the center the size of the mould. With the absorbing material used there is mixed a small quantity of disinfecting powder—sulphate of iron or green copperas—and there is a simple arrangement placed beneath the seat, whereby every time the closet is used, a shower of this disinfecting powder is sprinkled over the vessel and its contents. As soon as the dejections reach the vessel, the fluids are all absorbed by the porous substances on its sides and bottom. The solids are therefore left in a comparatively dry condition, and putrefaction is prevented, while the odor is neutralized by the disinfecting powder. It is claimed that the powder is not needed in outdoor closets.

It will be seen that the special advantages of the system are the utilization of the sweepings of houses, stores, and factories, for packing, the use of a powerful disinfectant, and the infallible prevention of nuisances, sometimes still contingent upon the use of earth closets, from neglect or disarrangement of machinery, or failure of earth supply. That which is to negative the most of the natural offensiveness is already in the tub, and will do its work even in the face of intentional neglect or willful attempt to make mischief.

So much can be honestly said in favor of this system. The claim of its backers, that it supersedes the earth-closet, is not admissible. The latter is nature's true democratic form of governing this important matter. If its product is rather bulky, so much the better; it will stay near and be used upon the soil that furnished the aliment that produced it. Monopolists cannot send it to fertilize distant lands. It may even be considered unfortunate, except so far as city product is concerned, that the dry earth can be used safely, half a dozen times, and the fertilizer thus condensed.

The Goux Urinal is a tall cylinder, in which is placed a funnel with a long perforated tube. The cylinder is so packed that the tube reaches to the bottom, while at the same time it is surrounded by absorbing material, mixed with disinfecting powder.

This system has already been introduced largely in Europe, and after a protracted trial made at Aldershot, during eighteen hundred and seventy-one, the British War Department, on the recommendation of several sanitary commissioners, specially appointed, has determined to adopt it. Although the contract was made and arrangements prepared for about four thousand men, yet the service has extended, without difficulty or inconvenience, to about eleven thousand or twelve thousand men, and no complaints have been made. In eighteen hundred and seventy-two, about fifteen hundred closets were in use every day in Halifax, England, and several large towns and villages in the manufacturing districts were making arrangements to introduce the Goux system.

This is a very important fact, for the Moule system had the start, and as the English are looking very carefully into this matter, it is a proof that they have found the Goux system specially adapted to the use of the rough, careless, slovenly men who usually inhabit barracks, prisons, etc. It is said that there are now about ten thousand Goux closets in use in England.

The *Scientific American* of January first, eighteen hundred and seventy-two, in an illustrated article on this machine, said:

"This form of earth-closet has been extensively introduced in London, where a corporation, known as the Sanitary Improvement and Manure Manufacturing Company, has been formed, and a large and profitable business inaugurated. The company employs a large number of drays and men, who go around to regular customers, removing the filled tubs and replacing them with others. The Town of Halifax, England, has also adopted the system, and will be soon entirely fitted. The Towns of Bradford and Wakefield, after a close examination of the results obtained at Halifax, have decided on adopting the system, and the company is in treaty with several other corporations for the same purpose. For hospital purposes, the system is excellent."

In the report of the Medical Officer of the Privy Council of England (eighteen hundred and seventy) appeared the following earlier testimony for the Goux closet: "This system is now somewhat extensively tried at Salford. The ordinary midden-closet can be converted into a Goux pail-closet at trifling cost, by cleansing out and filling up the midden, and paving the floor beneath the seat. An examination of the amount of nuisance arising from a pail-closet, as compared with the old type of midden-closet, in Salford, led us to conclusions largely in favor of the former. In no instance did we find offensive smell from the pail-closet. With proper care, they can never give rise to the abominable nuisance which is almost inseparable from the old form of midden."

THE PNEUMATIC SYSTEM.

CAPTAIN LIERNUR'S IMPROVED SYSTEM OF HOUSE DRAINAGE.

By ADAM SCOTT, C. E.

[From "The Sanitary Record," London, November 21st, 1874.]

The sewage difficulty is one of the most vital questions of the present day, owing to the many perplexities into which the existing sewerage system—the water-carriage plan—has brought so many of our towns. Any system of dealing with it effectnally deserves the most careful consideration.

There are many reasons to believe that Captain Liernur's plan has solved the problem in an efficient and satisfactory manner. His method of treating sewage having been in use for some years in Continental towns, the arguments he uses are not theoretical only, but are based on accomplished facts, his plans having had the advantage of a practical trial and having been found equal to the test. We propose, therefore, to examine it in detail.

Captain Liernur commences with the axiom that the aim of a town-drainage scheme should be not merely to remove filth, but, in addition to this, to keep air, soil, and subsoil water in a pure condition, and to maintain the last mentioned at a permanent low level. Hence he makes it his task to satisfy in the most perfect manner these various requirements, and he succeeds in it, as presently will be seen, without causing any nuisance whatever, and without laying any additional burden upon the ratepayers.

This last point is, in Captain Liernur's opinion, of very high importance in a sanitary sense, and perhaps more than many think; the doctrine of a great number of hygienists being that no expenditure can be too great for securing public health. Captain Liernur, however, points with great show of reason to the fact that the expenditure of large sums, without a return in kind, involves always an increase of taxation and consequent increase of house rent, which means for the working classes nothing else than crowding them still closer together in their already overcrowded dwellings, and in increasing the price of provisions and all necessaries of life. Now nothing contributes more to sickness and death in a town than such a condition of affairs, even apart from the general prostitution with all its horrors which accompanies it; hence it is that so-called sanitary works are of but little avail for improving the general health of a town if they are executed at the cost of

the comfort of the poor, no matter how beautifully such sanitary works may be carried out. Captain Liernur insists, therefore, that their aim should not only be to remove filth and to maintain the general purity of air, soil, and subsoil water, but also to give the working classes roomier habitations and an abundance of cheap and wholesome food, which, he maintains, can be done by a proper utilization of the sewage.

Accepting the above as the true basis upon which a scheme of town sewerage should be founded, it is apparent that our present system is entirely wrong. We remove the filth, to be sure, by means of fine-built sewers, water closets, and gigantic masses of water, but not without polluting air, soil, and subsoil water as we go along. We are constantly reminded of this by distressing cases of typhoid fever and other zymotic diseases, caused by sewer-gas poisoning, pollution of rivers, and by unceasing demands made upon the pockets of the community, in the as yet futile hope of remedying this truly miserable state of affairs.

In fact, it cannot be otherwise, when, regardless of chemical laws or the demands of sanitary science, we continue to remove the whole of the fæcal and other town refuse which is capable of being removed by water-carriage, in one common sewage conveyance, and wash it all pell-mell into the nearest stream. The system at present in vogue succeeds in getting, at a great expense, an indescribably nasty mess out of town to puzzle our engineers, and in creating still more noxious elements of pollution and disease inside to distract our sanitary authorities.

The leading principle upon which Captain Liernur acts is that of separation, in contradistinction of the present system of commingling everything in one sewer, his method being "*divide et impera.*" He classifies sewage in a similar manner to that which a carrier adopts in the transport of a mixed cargo of fragile and costly, and heavy and valueless goods, viz: by assigning each variety a distinct and separate conveyance, rather than by indiscriminately jumbling up the entire freight, thus doing enormous damage.

Thus he confines the duty of the sewer proper to the work of water-drainage only, and does not allow any putrescible matter whatever to enter therein.

Excrementitious matter of every description, such as the contents of closets and privies, chamber slops, and the fatty sedimentary products of kitchen sinks (which contain substances of a fæcal nature, but not yet in a state of putrefaction), are therefore all kept out of the common sewer, the arrangements for doing so being highly ingenious, simple, and effective.

Nor are the waste products of industry allowed to enter the sewer. Captain Liernur lays it down as a general rule that whoever makes water foul for the sake of his own private profit, must purify it before discharging it in the stream or sewer, and must do this at his own expense, instead of burdening his fellow-citizens with the refuse it contains. However disagreeable this purification may be to the manufacturer, there is no doubt that the principle is a correct one, as the solution of the sewage problem is simply an impossibility if the foul waste water of manufactories is allowed to complicate the question. Captain Liernur propounded and demonstrated this doctrine in the discussion on the sewage question at the recent Social Science Congress at Glasgow, and it deserves mention that it met the unanimous support of his many hearers, including the Chairman of the Section, the Right Hon. Dr. Lyon Playfair, M. P., who expressed himself most emphatically in this sense. Captain Liernur pointed out that it is comparatively easy to

cleanse factory water by separation, and in each individual case, the exact polluting elements being known and their presence constant; when, however, they are mixed with each other, with excreta and all sorts of other filth, are diluted with copious masses of water, and, to make matters still more perplexing, vary each day in volume and constituents, the work of cleansing becomes practically impossible; and even if anything like a purification method had after much research and experimenting been discovered, the erection of the very first additional factory, mixing again new elements of pollution with the mass, would make that method completely useless, and compel us to make new researches and experiments *ad infinitum*. Now, it must not be forgotten that the sewage difficulty, as a whole, is chiefly due to the part the waste products of industry play in it, and that it has cost already immense sums to overcome its evils and miseries. These sums come out of the pockets of the ratepayers, and are principally contributed by the working classes, who form by far the bulk of the population. Practically, it is thus the workingman, now earning with difficulty enough to support his family, who pays the bill which the manufacturer, by objecting to clean his own waste-water, declines to honor. The crying injustice of this is the more glaring from the fact, now on all sides acknowledged, that all the money has thus far been paid in vain, seeing that the methods on which it has been expended have all proved utter failures. Captain Liernur admits that in some special cases it might be an injustice to the manufacturer to make him bear the sole cost, and he suggests in such cases that the community should contribute towards it; but he insists upon a separate purification under any circumstances, as the only means of having it done at all. It must, however, be observed that, as actual experience has shown, it generally pays the manufacturer to do so, as the value of the product recovered generally covers the expense incurred, and often leaves a margin of profit besides. As national economy forbids any waste whatever which can be prevented without loss, it is evident that Captain Liernur's rule is a correct one on all points.

The difficulty which hitherto stood in the way of this part of the sewage question—namely, the one of detecting whether the rule of purification is absolutely attended to—Captain Liernur obviates by a very simple contrivance. A slight bend is made in the branch pipes leading to the sewer. This always retains some of the water flowing off, and on it a thin tube is erected, reaching to the pavement of the street, through which tube, by means of a small hand pump, the Inspector of Nuisances can at any time take a sample for examination.

The result of these various arrangements for excluding from the sewer the different matters alluded to—namely, all putrescible substances and all waste of industry—is that the sewer no longer conveys anything capable of generating noxious or infecting elements. Captain Liernur does not pretend that the water comes up to the standard of purity required by the Rivers Pollution Commissioners, but he points to the fact that the Local Government Board has admitted that the remaining fluid does not come under the designation of sewage, and that authority allows of its discharge in a stream without any further treatment.

But whether the authorities take this view of the matter or not, it is unquestionable that by treating the matter as Captain Liernur does, all danger of disease from sewage is removed. Here we have, in the first place, less reference to sewer gases than to the infectious germs capable of causing disease, and contained in infected excretal matters. These

germs are certainly not killed or rendered innocuous in the sewers of our present system of carrying off excreta; on the contrary, they are cradled there in an element favorable to their growth and development, and "ventilation of sewers" merely means that we give them opportunity of escaping more readily into the streets than into the houses. Hence it is that all suggestions on this point have so little sanitary value, the best arrangement to ventilate the sewers being also the best to spread infection among us so long as they are allowed to receive excremental matters. The impossibility of destroying the germs in the sewers is, in a sanitary sense, the weak point of the water-carriage plan, and one that can never be remedied; all projects of treating sewage at its outfall, including irrigation, leaves it wholly untouched.

The implied theory as to these germs is supported, among other people, by Professor Tyndall. In his letter of the sixth instant, to the *Times*, speaking particularly of typhoid fever, which annually infects one hundred and fifty thousand of our population, he says: "The seat of the disease being the intestine, with well-appointed water-closets, it is not in the sick room that the mischief is done, but often at a distance from the sick room, through the agency of the sewer, which Dr. Budd graphically describes as a direct continuation of the diseased intestine. Hence the mystic power of 'sewer gas.'" Hence the inability of the metropolitan practitioner to trace the disease to its origin. Speaking of the poison of this disease at Over Darwen, he says, "It reaches the drinking water, it partially dries and floats in the air, it rises mechanically with the gases issuing from cesspools, and thus the pestilence wraps, like an atmosphere, the entire community."

It follows from this that irrigation, precipitation, and other methods of treating sewage, supposing them to be ever so effectual, do not prevent the pollution of town soil, and consequently of wells, and the escape of germs of disease from the sewers in the town itself.

In Captain Liernur's system, however, such poison or germs can never escape from the sewer, simply because the substances which generate them never get in it, these being removed separately, and their volatile products being imprisoned, beyond the possibility of escaping, until they are destroyed by heat and made forever innocuous.

But whatever may be the nature of the liquid in Captain Liernur's sewers, very effective means are taken to prevent this also from doing injury, as these sewers are constructed so as to be practically impervious, being built of vitrified earthenware throughout, making either infiltration or percolation impossible. At the same time the subsoil drainage is effected by means of small agricultural drain pipes, arranged in the same manner as in farm drainage, but laid at a higher level than the sewer itself, and discharging into it by means of vertical pipes, laid at suitable intervals.

The sanitary advantage of this arrangement of drain pipes, in connection with an impervious sewer, is, that they keep the level of the subsoil water at a permanent height above the sewer, allowing no fluctuation whatever. Captain Liernur's theory on this subject is, that so long as the subsoil water outside the sewer is higher than the sewer within, all danger of pollution is avoided; there being no pressure at any time to force the sewage through the brickwork, as is the case with sewers which serve both for sewage conveyance and for draining the subsoil. In the latter case the level of the subsoil water, by reason of the porosity of the sewer, often sinks down to its very invert, and when at such a time rain occurs, and the sewer fills rapidly, the

level of the liquid within it will be higher than the water without, thus forcing the former through the porous brickwork into the soil, by mere hydrostatic pressure. When this occurs, however, the soil is at once in a state of semi-moistness and in contact with the atmosphere, conditions which are known to be highly favorable for putrid fermentation and the development of organic life, if such germs are present. This we know to be the case with water contaminated by excreta, even in the minutest proportions. Such a sewer is thus practically a contrivance which always impregnates the soil with the seeds of disease at the precise moment that it has the property of a hotbed for fostering them into ripeness. Experience has taught us that zymotic diseases have, beyond all doubt, the power of spreading, without absolute contact with infected persons or objects—leading to the conclusion that contagion also takes place through infectious germs present in the atmosphere, somewhat like poisonous insects, which sting or otherwise impart into our organisms the virus of the disease due to them. We further know that the fluctuations of the level of the subsoil water cause an alternative inhaling and exhausting of air, like breathing, each rising of the water forcing a strata of air of equal height upwards; so that there is, besides the agency due to diffusion and to the difference of temperature, a direct mechanical action driving the air, charged with the infectious germs, bred in the polluted soil of our towns, into the atmosphere of our streets and dwellings.

If the theory here stated be correct (and it must be admitted to be a logical deduction from cogent premises, to which some of our most eminent drainage engineers now subscribe), it is evident that the plan of conveying sewage containing putrid organic matter, and of draining the soil, with one and the same conduit, as is done at present, is nothing less than a means of spreading the germs of infection additionally to the one above alluded to, by allowing them to escape direct from the sewer itself through means of ventilation, and would go far to explain the difficulty we have of checking typhus in a sewered town when it has once made its appearance. By Captain Liernur's plan, on the contrary, of withholding from the sewers, as far as practicable, all putrescible matter, so that no infectious germs should breed within them, and then constructing impervious sewers, and having porous drainage-pipes laid at a higher level above them, the danger of infecting the air with germs of disease by means of polluted soil, and the fluctuation of subsoil water, will be wholly prevented.

Captain Liernur claims, for his plan of keeping the subsoil water permanently above the sewer, another important advantage. It enables him in times of the maximum rainfall to keep columns of water within the gully trap-pipes, so as to exert, without any danger of polluting the soil, a hydrostatic pressure on the contents of the sewer, and thereby greatly increasing the speed of its flow. Instead of making the area of the sewer large enough to carry off storm-waters (that is for the usual proportion of this generally counted upon for removal by sewerage, namely one third,) with the speed of flow due merely to the gradient of the sewer, he calculates upon the increased speed of the flow due to the above-mentioned columns of water, in the gully pipes, to carry off that same maximal quantity with a smaller sewer, never however allowing these columns to rise higher than within one foot of the permanent level of the subsoil water, so that the hydrostatic pressure without is always greater than the one within. As the speed of water flowing through a pipe becomes greater in proportion to the increase of

the column of water resting on it, it is evident that the capacity of discharge of a small sewer, under the above circumstances, may be made equal to that of a larger one built on the ordinary plan. Captain Liernur is thus enabled to effect the same purpose with smaller sewers, which cost much less than the present large ones, and obtains also the additional advantage of scouring them perfectly free from the deposits often formed at a normal height of the sewage when its speed of flow is due only to the gradient of the sewer, and thus practically effects the "flushing" without the expensive arrangements which are commonly applied for that purpose.

The branch pipes from the Liernur common sewer terminate in a trap outside the house, and open to the air. The sewers are thus well ventilated, and cannot force any of the air (or gas if such could be formed) contained in them into the house.

Summing up the whole of the advantages which Captain Liernur's above-described plan of town drainage offers, it is undeniable that it effectually overcomes all the evils of our present system. It puts an end to sewer-gases, and thus makes the many perplexing projects for sewer-ventilation perfectly superfluous. It absolutely prevents the pollution of the soil, and fluctuation of subsoil water. It prevents also, in the most certain manner, all pollution of streams, and accomplishes these objects at a less cost than our present system, which pollutes the air, soil, and subsoil water, and the stream as well.

The next important part of Captain Liernur's plan, his so-called pneumatic system, is solely arranged for the separate removal and utilization of all putrescible matter of households capable of being conveyed by subterranean pipes. It is this which enables him to carry out his whole scheme in populous towns without increasing taxation, and, therefore, without committing the error of the water-carriage plan in this respect.

The first characteristic of this system is, that the matter alluded to is removed out of the houses by atmospheric pressure, instead of by water, being drawn, or literally sucked, by vacuum power, to a central building in the town where an air-pump engine works.

The second point deserving special attention is, that the pipes conveying the matter from the houses to the engine building are five-inch cast iron socket pipes throughout, the "mains" not being any larger than the "branches." The matter is thus removed without the use of wagons and horses, and laborers entering dwelling houses, and without the remotest possibility of the contents of the pipes polluting either the air or the soil of the town. A leak would only result in either atmospheric air or the surrounding soil rushing into the pipes, and any escape of gases or fluids is absolutely impossible. Experience has confirmed this theory, inasmuch as leaks occasioned by the shifting or settling of the pipes have been found to stop themselves. It may be mentioned also that the air pumped out of the network of pipes for creating the vacuum is exhausted by the air-pump into the fireplace of the engine-boiler, thus burning the noxious elements which such air may be charged with, and rendering them innocuous.

The third point of interest in the system is, that in the whole network of pipes there is from one end to the other not a single valve or other movable mechanism which is expected to act or to do something when the pneumatic force is applied. All parts of the arrangement are fixed and immovable. There is simply on every main-pipe one single ordinary stopcock, which is turned by hand on the street, and when

this is done all the closet-pipes of the houses connected with that "main pipe" (one hundred, two hundred, or however many there may be), are emptied simultaneously. Hence there is nothing to get out of order, to cause a nuisance, or to necessitate costly repairs. The stop-cock itself is of the simplest construction, being only a conical plug in a vertical housing, capable at any time of being lifted, examined, and replaced, should it be necessary.

The fourth peculiarity is, that the simultaneous emptying of all the closet-pipes, which are operated upon by one main pipe, takes place independently of the fact that any one may receive more excremental matter than another, or even none at all. The closet-pipe nearest to the stopcock, which is the place where the motive power is applied, is not acted upon a moment sooner than the one farthest from it, and it is all the same whether a closet-pipe receives the fæces of a hundred persons or of only one individual. The arrangement by which this effect is produced is not only a marvel of ingenuity and simplicity, but is also remarkable for its absolute reliability as to regular action, being based upon a simple law of barometric resistances, operating upon small columns of the fæcal matter itself, which will be explained.

The fifth point deserving of notice is, that practically no fermentation nor evaporation takes place within the pipes. This is due to the fact that their contents are cut off from all communication with the outer air, free contact with this being, as is well known, the first essential both for evaporation and putrefaction. The excreta thus remain practically fresh until the moment of the removal, no ammonia being formed, which afterwards would require to be fixed to prevent its loss. They remain also practically unchanged as to their fluidity, so that there is no fear of "drying up," which on the one hand might limit the action of the columns of fæcal liquid above alluded to, or cause encrustations in the pipes, and thus eventual stoppages.

The sixth peculiarity is, that the matter collected is immediately converted into a dry substance called *poudrette*, by simply evaporating the water from it. This process occurs *in vacuo*, so that no organic matter can escape in the form of vapors or gases. In fact, the matter sees no daylight after being once deposited in the closet-pipes, until transformed into a harmless powder. Hence there can be no question either of a nuisance or of any loss of valuable ingredients.

The seventh and last point of interest is, that no extra fuel is used for the evaporation or distillation process. The waste steam of the air-pump engine which collects the matter is employed as a source of heat, and is found ample for the purpose in most cases. Thus all the manurial elements contained in the putrescible refuse of the town are saved and brought without extra cost into a portable form like guano, of nearly the same value, and fit like it to be shipped to any distance where there is a market for manure.

A careful consideration of the above seven main features of the pneumatic system will show that every requirement regarding the removal and treatment of putrescible matter is complied with.

The complete impossibility of its contact, either as gas or liquid, with anything outside the pipes, makes the system sanitarily perfect; the reliability of the agencies brought into play, coupled with the absence of all complicated machinery or apparatus which may get out of order, satisfies all demands from a technical point of view; and through the combination of the cheapest moving agent we have, air, with the complete utilization of the cheapest motive power we know, steam, for the

purpose of manufacturing an article for which there is a continuous and increasing demand, manure, out of substances of the highest agricultural value, human excreta, in a light portable form, everything is done which in a financial sense could be demanded.

We will now describe the simple arrangement with which Captain Liernur succeeds in obtaining these excellent results.

He selects in the town to be drained suitable places to serve as centers for the drainage of a number of houses, generally fixing the localities of these at the intersection of principal streets, so as to command from such centers areas of from thirty to fifty acres. There he places beneath the pavement tanks of from four to ten cubic feet capacity. These are cast-iron horizontal cylinders with spherical ends, constructed so as to be air-tight and strong enough to resist atmospheric pressure. Pipes are laid along the streets leading to the tanks, to act as "mains," and from these mains other pipes branch off right and left to the houses, where they are connected with the closets and other receptacles to be drained. Every tank has thus as many "mains" as there are streets leading to it. Each "main" with its branches is, however, as to its drainage action, a distinct and independent arrangement from the others, and has a stopcock for itself placed at its junction with the street tank.

When, now, a vacuum is made in the tank, and the stopcock of any one of its mains opened, all the closet-pipes connected with that main are emptied simultaneously, their contents being transferred into the tank. Experience having shown that a simultaneous action is had even with mains of nine hundred feet length, it is evident that one tank can serve for the drainage of all houses within a radius of that length, equal to an area of about fifty acres, so that the towns can be divided (other circumstances admitting this) into drainage complexes of about that size, each of which is practically independent of the others, in the same manner that each main pipe of a tank is independent of the others.

The vacuum in the tanks is, as mentioned above, created by a stationary air-pump engine, which communicates with them by means of pipes called central pipes, because they form the connecting link between the tanks and a motive agency which is common to them all. The central pipes follow only the principal streets, taking the most direct routes from the engine house to the greatest number of street tanks along their line. The length of a central pipe may, under certain circumstances, be four to five miles.

The manner in which the system works is the following: One main pipe is made to operate on a great number of houses, one tank on several main pipes, and one central engine on numerous tanks; an arrangement somewhat analogous to a military organization, where one colonel commands several captains, one captain several sergeants, and one sergeant several men.

The central pipes serve, however, not only for communicating the vacuum to the various tanks, but also for conveying their contents to the central engine buildings after their several main pipes have all contributed their quota. This is effected also by simply turning a stopcock specially provided for the purpose.

The manipulation of the system is as follows: The air-pump engine is set in motion, and maintains, during the day, a three-quarter vacuum in certain central reservoirs placed below the floor of the building, and at the same time in the central pipes. Workmen perambulate the town,

visiting each tank once a day. To drain the houses commanded by one tank, they alternately open the connecting cock of the central pipe and the stopcock of any main pipe; the first to obtain a vacuum in the tank, the second to utilize this by emptying the closet-pipes connected with that particular main. After all the mains of the tanks in question have been operated upon, and their contents collected in the tank, the workman turns the discharging cock to send the whole mass to the central building for immediate conversion into *poudrette*. He then proceeds to the next tank, there to repeat the operation.

To describe the arrangement mentioned above, for effecting a simultaneous discharge of all the closet-pipes drained by one main, notwithstanding the unequal quantities of fæcal matters collected in them, it is necessary first to explain how it is possible that air-pressure can be used at all for conveying fluid substances through pipes. It will be easily understood that this is not possible when the pipe lies horizontally. The fluid is then soon thrown to the bottom of the pipe and spread over a limited length of it, which the current of air passes over without being able to move the liquid further. But it is very practical to suck liquid up a vertical pipe without this danger of spreading, seeing that in such a case it is naturally held together and moved in mass. When, now, it is in this manner raised to the upper end of a pipe having a gradient steep enough to allow the fluid to flow down by its own gravity, it is evident that a forward motion will be obtained, equal in its effect to a horizontal movement, but without any of the fluid being left behind on the way. Supposing the gradient capable of allowing this, an inclination of one in fifty is required, then it would be sufficient to raise up the fluid one foot vertically in order to move it fifty feet horizontally; or, in other words, for every fifty feet forwards it would have to be moved one foot upwards.

It is upon this principle that Captain Liernur lays his pipes, so that they present a series of downward lines alternated by short vertical ones, or "risers," there being at the foot of every downward pipe an upward bend, in which the fluid collects to be raised anew to the upper end of the next incline. The work of moving the fluid by air-pressure, through pipes horizontally, consists thus practically in a repetition of hydrostatic lifts.

The circumstance that this is the only method for effecting his purpose, Captain Liernur now utilizes for obtaining equal resistance in all the branch pipes of the "main," irrespective of the quantities of fluid in them. To obtain this result he simply gives each branch pipe "risers" of the same height.

The effect of this is manifest when it is considered that an inclined pipe, with an upward bend at the foot of it, represents, in fact, a barometric tube with arms of unequal length, and that when both arms are filled with fluid to an equal height, the hydrostatic pressure in the one arm will be balanced by the pressure in the other. The *static* resistance then to be overcome in order to set the liquid in motion will thus be *nil*, because where there is no difference in levels, there is no hydrostatic lift. But if the liquid in the short arm of the tube is drawn upward (by suction, for instance), so as to discharge the fluid at its upper end, it is evident that the resistance increases in proportion as the level descends in the long arm, and that this resistance attains its maximum when the level is lowered to the junction of both arms. The height of the short arm represents therefore the maximum resistance to be overcome.

This being the case, it is evident that the entire contents of the long arm will be discharged before the maximum resistance is reached; and that, in fact, adding to the fluid in the pipes means nothing else but diminishing the resistance. In other words, the resistance to be overcome is *maximal* when the quantity to be lifted is *minimal*, and *vice versa*. It is hence easily seen that when Captain Liernur gives all the risers of the branch pipes of one and the same main pipe, an equal height, he limits in all of them the maximal resistance, this being just the contents of the short arm of the tube, or riser, and no more. When under these circumstances any of the long arms should contain more than is required for this purpose, the surplus will be discharged, however much that may be, before the resistance, due to the minimum quantity, will be reached. The effect of the arrangement on unequally filled branch pipes of a main pipe is, therefore, simply that the one most full begins to discharge the soonest, and so on, every other following according to the quantity of its contents, the one having the smallest quantity beginning to discharge last.

When, however, all the branch pipes have discharged their surplus, their contents are reduced to the minimum necessary for just filling the vertical riser and no more. Then and not before is it that the resistance in all becomes exactly equal, that is, has reached the maximum; the action on all becoming then alike. Now, this is, so to speak, the strong point of the arrangement, for when in each pipe the minimum quantity is reached, no more fluid is discharged. The air rushes through and leaves that minimum quantity behind, filling the riser and forming a prop or liquid trap, which, when the next emptying process takes place, keeps the vacuum from being entirely destroyed through undue admittance of air. Each branch pipe is thus automatically provided with the material which insures the regular discharge of the surplus quantities of all the others, without having to use any valves or other mechanical contrivances for the purpose. Nôr is there any danger that such a quantity can be diminished by evaporation. The bends in the pipes make it impossible that moisture in the shape of vapor should escape. The only thing required to set any branch pipe at work when it is once joined on to a main, is to throw a little water in it, just sufficient to fill the riser, and its proper operation can then be forever afterwards implicitly relied upon.

With reference to this arrangement we may repeat that the keeping small quantities of fæcal matters in the risers of the pipes, for the purposes mentioned, neither gives offense, nor changes the character of the fæcal matter; as there is no contact with the outer air, there can be no more putrefection or fermentation going on than in the air tight sealed tin vessels which are used for preserving meat, etc.

In fact, the arrangement is, in whatever light it is looked at, absolutely perfect; and when one compares the great many difficulties and intricacies of the problem embraced, one cannot but admire the simple, effective, and elegant manner in which Captain Liernur has solved it.

We next come to the improved closets Captain Liernur employs. He does not allow the water-closet at present in use by us to be connected with his pneumatic system, urging as a reason for this its sanitary, æsthetic, technical, and social imperfections, which in many cases we cannot but admit. There is a great quantity of water used, but it generally lies at such a low level that the excreta obtains in falling a momentum causing it to fall through the water and often to adhere to the basin, besides frequently wetting the person who uses the closet, owing to the

water splashing up. Then it requires for its action the turning or lifting of some handle, which many persons forget, thus entailing upon the next user a disagreeable task. Finally, its mechanism is too delicate, making frequent repairs unavoidable. This getting out of order, apart from the cost it entails, is an abominable nuisance, which once and for all excludes from the use of the water-closet about two thirds of the population of a town, namely, the working classes.

To supply these deficiencies Captain Liernur provides for his pneumatic system two kinds of privy arrangements, namely, a water-closet for those who imagine that they cannot do without such a convenience, and are willing to pay its cost; and the so-called pneumatic privy for the poorer classes, the latter being in his judgment not only cheaper, but sanitarily the more perfect.

The chief feature of the water-closet consists in the basin being a sort of chamberpot, placed so close under the opening in the seat, that the surface of the water is no further from the body of the person than it would be if he really used such a utensil. This basin turns on one side on a hinge, being held horizontally ready for service so long as a person is in the closet apartment, and tilts and empties itself in a syphon below, the moment he has left. This motion is obtained by the weight of the person, pressing down floor and seat at the same time; the length of the stroke being only half an inch. The moment he enters the basin is lifted in a horizontal position, the water, which is now only one quart, neither more nor less, is poured in. This quantity is sufficient for the purpose. The excreta does not fall now from a height, but glides into the water, and is kept floating without soiling the sides of the basin. The chief merit of this combination is, that one quart of water only is used, and that its application and the discharge of the excreta afterwards in the soil pipe below, occurs automatically and independently of the will of the user of the closet.

The pneumatic privy has no movable mechanism at all, and is used without any water for flushing. The excreta falls into the bottom of a deep funnel, but the size and position of the seat opening is so arranged, and the shape of the funnel is so made, that the extreme area in which the excreta can fall is practically as much limited as would be the case in an ordinary chamberpot. The effect is that the excreta falls and is collected in a pocket below of but small compass, without touching the sides of the funnel, offering to the air a surface of only five inches. The pocket referred to is one arm of a short bent tube or syphon trap, discharging in a soil pipe. This discharge is effected by the weight of the excreta, fluids and solids, themselves, each new deposit forcing the former out. Thus the older matter is automatically shut off from further communication with the outer air, and it being well known that no fermentation capable of generating elements dangerous to health takes place within the first thirty hours after production, it is evident that the small surface of fresh substances exposed to the air could at the utmost only throw off offensive gases. To carry these off, however, each funnel is ventilated by a two-inch pipe placed close under the seat and leading to the outside of the roof of the house, and furnished on top with a so-called Wolpert's air-sucker. This little contrivance, scarcely known in this country, is very simple, having no movable parts whatever, but is singularly effective; the slightest and almost imperceptible motion of air (which in towns is never quite still) causes an upward current in the pipe, provided the difference of temperature between the outer air and the air of the apartment is not too great. To prevent this

occurring, the window of the apartment is made so that the outer air can always communicate with the air within.

The result is that when the lid is removed from the seat-opening a current of air strikes at once downwards into the funnel. From this it is evident that under no circumstances can an offensive smell escape from the funnel into the apartment. The funnel itself being of a dark color, throws no reflected light on the excreta below. It is plain, therefore, that there can be nothing to offend either the sense of sight or the sense of smell; and this is all that can be expected from the best water-closet.

This is now established by experience. The various official reports of impartial judges are conclusive on the subject. Among many, we may especially mention that of the Medical Inspector of Ho'land, Dr. Egeling, who states that all the Medical Inspectors of the Netherlands are unanimous in this respect. Further, the report of the President of the Medical College of Saxony, to the Minister of the Interior of that Kingdom; also that of the Director General of the late Vienna Exhibition (where these closets were in use during the whole time it was open); and the reports of a great many commissioners of towns, which all agree in confirming. Practically, the most favorable testimony of all consists in the fact of the satisfaction these closets give in all places where the plans of Captain Liernur have been strictly followed.

The Chief Engineer and Director of Public Works of Amsterdam, where Captain Liernur's system has been adopted in spite of strenuous opposition, and universally commended, submitted a report in July of this year to the Common Council, calling the Liernur system absolute perfection in a technical and sanitary sense, and recommended its extension to the whole of the new town and the most populous part of the old; and in like favorable manner the Chief Clerk of the Public Works expressed himself in a series of answers to questions put to him on the subject, which were published in the London journal, *Engineering*, of August twenty-eighth of this year, and which gives an idea of the opposition made.

With the same view of enabling our readers to obtain correct information, we advise those who wish to see the working of the system to go to Leyden, where it has been in operation for over three years in a few streets, by way of trial. The works there, although executed after Captain Liernur's earlier plans, since which many improvements have been effected, has given such unbounded satisfaction that last month the principal citizens (among whom were the entire Faculty of the University), petitioned the Common Council to apply the system forthwith to the whole town; and the Committee for Finances have recommended since then that Captain Liernur be charged with preparing plans for that purpose.

In Rotterdam and Dordrecht, the commissions who were appointed to report on the subject have also recommended this system for application to the whole of these towns, basing their recommendation on the good results obtained in Leyden and Amsterdam, and in Dordrecht the works are now already in process of execution.

Before leaving the subject of Captain Liernur's closets, attention must be called to the fact, that the pocket into which the overflow of the privy funnel proper takes place is also ventilated. This pocket, being a bended tube discharging into the branch-pipe, is the real receptacle from which the fæcal matter is permanently removed; all the same, whether it belongs to the water-closet or the pneumatic privy of the

system. The pipe provided for the ventilation alluded to, serves at the same time for admitting the atmospheric air for the pneumatic process. Hence such air does not enter through the seat opening. We mention this here to set at rest the idle tales which the enthusiasts of our present water-closet system have started on this subject. The ventilation pipe in question is furnished, in its upper part, with a charcoal filter, for the purpose of deodorizing any gases which might increase the tension of the air enough to allow it to escape, and the deodorizing power of that charcoal is daily revivified through the violent downward current due to the pneumatic process.

It will thus be seen that, both in his water closets and in his privies without water, Captain Liernur has provided for every contingency.

The above account of the system would be incomplete without a description of Captain Liernur's method for making *poudrette* from the substances he collects by the pneumatic pipes.

First, a few words as to the substances themselves. We stated that they consist of all the putrescible matters of households, namely: the usual contents of the privy closets, with their contingent of chamber slops (urine and wash water), which generally find their way into them, and the sedimentary matters of the kitchen sinks, consisting principally of the fragments of waste food, washed from dishes and cooking utensils. We omitted, however, to mention the proportional quantities of each of these refuse matters. This is necessary in order to understand the practicability of the method now in question.

At first sight, it might appear that the admission of wash water in the chamber slops, of sediments of the kitchen sinks, and of water-closets for the wealthier classes, would cause such a considerable dilution of the privy matters proper as to form an impediment to the profitable manufacture of *poudrette* by distillation. It is easy to show that this is not the case.

As regards the wash-water of sleeping-rooms, the proportion of the total quantity of a town to be dealt with is much less than many will suppose. The bulk of the population is made up of the working classes, and their sleeping-rooms seldom contain the toilet requisites of their wealthier fellow citizens, namely: wash basins, chamberpots, and slop pails. As a rule, the families of small tradesmen and laborers perform their ablutions in one basin common to all, and placed near the water-tap. The water, after being used, is usually thrown into the sink under such tap, while the privy receives the urine of the family direct. Each liquid flows directly to the place where it belongs; few would think of going to the privy to throw away wash-water, or to the sink for disposing of urine. The families having slop-pails, chamberpots, and wash-basins in sleeping-rooms for each member of the household, comprise at the utmost but one sixth of the population. Assuming this to be the case, and supposing that each member of such families used three quarts or one hundred and twenty ounces of water for his morning ablutions (for only the sleeping room quota is here the question), then the average dilution of fæcal matters from this source per inhabitant for the whole town would be only twenty ounces per day.

This dilution is, however, amply made up for by the sediment of the kitchen sinks, containing nearly all alimentary and fatty matter used in a household, which has not been consumed as food, and obtained an excretal form. As an average per day per inhabitant for the whole town, the weight of the urine, fæces, and kitchen-stuffs may be reckoned together at one kilogramme, or forty ounces, of which about four ounces

belongs to the sink refuse, having the form of a slush made up of small fragments coated in fat, mixed with pappy water.

That it is obtained in this form, and not more diluted, is due to the exceedingly ingenious apparatus Captain Liernur employs for separating it from the household water running off to the common sewer. It is a trap placed at some suitable spot in the open air, into which all kitchen and household water discharges. In order to flow off into the sewer, all this water must pass upward through a close grating, which acts as a strainer. The sediment is thus thrown down into a sort of pocket, which stands in communication with the privy-soil pipe. When now the pneumatic blast takes place, the pocket of the sink is cleaned simultaneously with the closet-pipes; the air to do this, which enters through the grating, blows it clean at the same time. It may be mentioned here that this trap is open to the air outside the house; all direct air-communication between the sewer and the house is thus cut off. Captain Liernur has thus practically forestalled the very valuable suggestions, with a like aim, which, under the signature of "M. D.," appeared lately in the *Times*, and were so much approved.

It must be remembered that the substances collected in the trap are chiefly unconsumed particles of food, the putrefaction of which at any rate does not take place within the first few days; until such is the case they cannot impart to the water charged with them much organic matter in solution. Hence it is evident that the prompt separation and removal which Captain Liernur effects keeps the effluent water which runs off to the sewer practically clean from polluting organic matter, and does not in either case impart to the sewage any elements capable of breeding disease by generation of gases or germs. Whatever may be the nature of that water, there is no question that Captain Liernur adds by his separation a valuable contingent to the manurial substances he collects, since in weight it amounts to almost as much as the solid excrements produced, and is nearly all composed of the same substances.

The aggregate of the matter collected, with the proportion of slops above alluded to, is equal to about sixty ounces per average inhabitant per day. Of this ninety per cent, or fifty-four ounces, is simply water.

The method followed by Captain Liernur, to convert the matter into a dry powder, consists in separating this ninety per cent of water from the solids by evaporation or distillation. He avoids the error of those who seem to think they can precipitate organic matter in solution, which is a sheer impossibility. The source of heat employed for the purpose of distillation he finds in the waste steam of the air-pump engine which collects the matter. To understand the possibility of this, it must be remembered that in few steam engines is there more than seven per cent of heat which the steam takes up in the boiler, converted into motive power, and fully ninety-three per cent escapes in the exhausted steam.

The heat in question is called latent heat, which is measured in physics by caloric units, one such unit being the amount of heat employed to increase the temperature of one pound of water or steam by 1° Fahrenheit. So long as steam retains the form of steam, the amount of calorics necessary for its existence is contained in it, otherwise it would not be steam at all; and this is the case with the waste steam of a high-pressure engine. The amount of caloric depends, of course, upon the degree of sensible heat of the steam, and upon the number of pounds of steam there is at one's disposal. It is, in fact, this sensible heat which has been diminished in giving off work. Thus one pound of steam of ninety pounds per square inch pressure contains 1,179·7 calorics, with a

sensible heat of 320·5° Fahrenheit. After escaping from the cylinder, however, it will be cooled off to about 212°, but will contain 1,700 calorics, which can be given off to any substance the steam comes in contact with.

A sensible heat of 212° Fahrenheit is, however, too low for evaporating purposes, unless under a much diminished pressure. Captain Liernur, therefore, follows the example of sugar manufacturers in applying that heat to the fluid to be evaporated in combination with a partial vacuum; and as the vapor arising from such a boiling contains still a considerable amount of heat, measurable in calorics, he uses it for a second evaporation process. The practicability of this may be understood at once, when it is considered that a fluid may be set boiling with the steam of another fluid, and this may be repeated. Sugar manufacturers call this process a double effect, or a triple effect, the last being when the vapor of a second boiling is used for a third.

To economise still further the exhaust steam of the air-pump engine, it is conducted through coils of pipes placed in the flue through which the hot gases and smoke from the boiler pass to the chimney. Its sensible heat, as experience shows, is increased by this process to about 230° Fahrenheit, and the supernatent moisture transformed again to dry steam. The whole becomes thus practically dry steam, containing about 1,152 calorics in the pound.

This dry steam, of 230°, is now conducted through coils of copper pipes placed in an upright hermetically closed boiler. Into this, about midway in height, the fæcal matter is admitted, after having been mixed with one per cent in weight of sulphuric acid, to prevent the formation of ammonia during the evaporating process. The admission takes place continuously, and the matter is continuously withdrawn from the bottom, it then having lost about half of the water it contained. This loss is occasioned by the evaporation, due to the heat of the steam of 230° circulating in the coil of pipes, and due to the fact that the vapors are carried off to a condenser, thus producing a vacuum of twenty-five inches mercury, under which reduced pressure the boiling point is reached at as low a temperature as 203°.

This condenser is formed by the second apparatus. It principally consists of a horizontal copper cylinder, revolving on its own axis during the time that it receives the vapors of the first apparatus, and is suspended in a shallow trough, into which the already thickened or reduced matter from the first apparatus flows. In rotating, it becomes on the outside covered with a thin layer of that substance. This thin layer is hence heated nearly to the degree which the vapors of the first apparatus impart to the inside of the second. But this cylinder itself is housed in a hermetically-closed vessel, which stands in connection with the air-pump engine. By means of an ordinary cold-water spray condenser, the pressure within the vessel is kept down to about 13.6 inches mercury, under which the boiling point is reached as low as 175° Fahrenheit. Under the combined effect of this degree of vacuum, and the heat imparted at 203°, the final evaporation of the thin layer in question takes place extremely rapidly, and it becomes a crust, baked on the outside of the revolving cylinder. A stationary slanting knife (or *docteur*), placed underneath, meets the cylinder in its turning round, and scrapes this crust off in the form of small flakes or shavings, which, without any further manipulation, is the *poudrette* wished for. It falls in a box placed on rollers within the apparatus, which is opened in the

evening. The *poudrette* can then be taken out and put in bags for transport to manure markets, like guano.

The whole apparatus is, from a technical point of view, exceedingly simple and effective, Captain Liernur having in the details taken care to employ only mechanical combinations which have stood the test of practice in similar contrivances. The chief merit, however, of the process, is the absolute certainty that all manurial elements, organic or mineral, are recovered in the substance obtained. As nothing can escape into the air in the shape of gases or vapors, seeing that the conversion takes place *in vacuo*, it is evident that all the ingredients must be present either in the *poudrette* or in the water distilled from it. The latter is shown by analysis to be far purer than the standard of drinking water prescribed by the Local Government Board. The only conclusion, therefore, is, that practically all manurial ingredients must be contained in the *poudrette*.

It is especially necessary to draw attention to these figures, as they will form the basis of future remarks, when it becomes necessary to allude to the opposition which has been made to the plan of Captain Liernur in Amsterdam. The inventor is satisfied to rest his claims on the tangible results which have been accomplished.

An analysis by Professor Voelcker, Chemist of the Royal Agricultural Society, dated August fifteenth, eighteen hundred and seventy-four, of a sample submitted to him by Sir Philip Rose, Bart., showed it to contain:

Moisture	8.64
Organic matter (1)	62.96
Oxide of iron and alumina	3.29
Phosphoric acid	1.76
Lime	0.86
Chlorine	6.22
Sulphuric acid	6.02
Alkaline salts	8.20
Silica	2.05
	100.00

Professor Voelcker here estimates its value to the manure merchant at eight pounds and ten shillings per ton.

It is easy to deduce from this the money value of the manure produced per day and head of population. As the daily weight of *poudrette* per head is six ounces, the annual product would be over one hundred and thirty-six pounds, which at eight pounds and ten shillings per ton of two thousand two hundred and forty pounds, gives over ten shillings per head per annum.

There is little doubt as to the correctness of this value, as it agrees substantially with nearly every estimate made by acknowledged authorities who have written on the subject.

(1) Containing nitrogen 9.35, equal to ammonia 11.35.

If the objection be raised that it has never yet been practically proven that the commercial value of sewage is so high, and that therefore no reliance can be placed upon the foregoing estimate, such objection would be based upon entirely erroneous premises. It is quite true that the manurial ingredients extracted from the sewage of our present system have no such value, but this is not because the valuable ingredients were not in the sewage, but because they are in such a state of dilution that they cannot profitably be extracted. Like a few grains of gold diffused in a large mass of quartz, there is no doubt concerning the value of the gold, but a great deal as to its being enough to pay the trouble of separation. It is the same with the highly diluted sewage of our present system. There never was, and most probably there never will be, a process capable of extracting the manurial elements from it at a profit. For evaporation the dilution is too great, and precipitation involves a chemical impossibility, seeing that the most valuable ingredients (the organic matter) are in solution, and can therefore hardly be precipitated at all. The process of immediate application on land by irrigation, which was once hailed as *the* means of delivering us from our sewage trouble, has proved fully as delusive. Experience has shown that, unless under very exceptional circumstances, no farmer can afford to pay anything for manure in the ordinary form of sewage. The dilution makes the cost of bringing it to the land too heavy, and the quantity required per acre (the annual sewage of at least one hundred persons) too great for this. This is the case, no matter how enormous may be the crops to which the sewage-farm enthusiasts constantly point, as compared with those of ordinary farming. Whatever these gentlemen may say on the subject, it is doubtful whether any of them would like to erect a pumping-engine and build miles of culvert from the town to his farm in order to convey sewage to his fields all the way at his own expense, as is done in ordinary farming with the excreta of men and animals in an undiluted state. The fact is that in most cases the town has not only to furnish the sewage gratis, but has to be at the cost of pumping it up in addition, so that the farmer can distribute it conveniently; this mode of utilization becoming thus, instead of a source of profit to the town, only a matter of additional expense. To our mind, any mode of farming has very little to recommend it on the score of agricultural merit if the primary conditions for a profitable return are that the land is cheap and that the manure costs nothing, either in purchase or carriage, and such is practically the case with sewage irrigation.

These demerits might perhaps be overlooked if sewage irrigation were perfect in a sanitary sense. There are many grounds, however, for considering that it is objectionable besides the financial and agricultural ones; this question is, perhaps, foreign to the matter immediately before us, but it is quite as well that it should be glanced at in connection and comparison with Captain Liernur's system.

The advocates of irrigation claim it to be a mode of making sewage innocuous without danger to the public health; and some enthusiasts add still greater merits, holding it to be a cure for all evils, including infant mortality. Captain Liernur, however, observes, not without good reason, that there is very little to prove that the germs of zymotic diseases, contained in infected excreta and discharged into our sewers, are killed by depositing them on a soil sodden with putrid matter. Such, he says, may perhaps be the case, if they then happen to come in contact with the stems of plants having the faculty of absorbing organ-

isms without previous decomposition. But such plants are exceptional; and in every case there are open spaces between them, which occupy by far the greatest proportion of the area of the land. Hence the germs in question, instead of being killed, have much more chance of being brought under the fostering agency of the combination of moisture, heat, air, and putrid matter, which is peculiar to the surface of all marshy soils covered by plants. So far from there being any reason to suppose that this combination tends to destroy such germs, there is a very great probability that it is genial to their vitality. The microscopic examinations of the uppercrust of the Dantzig irrigation-fields by Dr. Niedner, of Dresden, goes far to confirm this hypothesis. That naturalist found it to be a living mass of bacteria and vibriones, to such an extent that they formed the substance which kept the particles of sand adhering together. Now, if these organisms flourish under such circumstances, why should such not take place with the germ or whatever it may be, of cholera, typhoid, etc., discharged from the intestines of sufferers by these diseases? That the immediate neighborhood of such fields is healthy proves nothing to the contrary. According to Captain Liernur it proves equally well that the germs in question, after being taken up in the atmosphere, were carried elsewhere. The possibility of their being thus conveyed can hardly be denied. He deems it demonstrated by the fact that zymotic disease often appears suddenly in places far removed from where it is raging, without traceable or possible contact with persons or objects from the infected spot. He does not doubt that germs of disease can be spontaneously generated; their very existence showing that this has occurred once, there is no reason why it should not occur again, and it is simply the question whether all the factors and conditions necessary to such creation are present. This, however, involves, as Captain Liernur justly remarks, equally much the necessity of none of them being missing. Seeing, now, that for this purpose there must be on hand, besides the required structural elements, a particular combination of moisture, temperature, absence of ozone, and more probably an influence of telluric origin, it is evident that there are a great many chances which can prevent the generation in question at all; small differences from the required degree of temperature, moisture, telluric peculiarities, etc., being more probably sufficient for this. The sudden appearance of zymotic disease in a place far removed from another which is suffering from that disease is hence far more likely due to an imported germ. And in case, as was supposed above and so frequently happens, there was no contact with infected persons or objects, it is evident that only the atmosphere was the carrier, and that hence such germs have the faculty of being taken up by it, and float about like any poisonous insect.

Captain Liernur, however, points to danger of infection from still another quarter in connection with sewage irrigation. It is to the fact that the plants take up but a small portion of the nitrogen contained in the immense masses of sewage with which they are flooded, and that the greater part finds its way to the subsoil in the shape of nitrites and nitrates. He considers in connection with this the other well-known fact that the germs or infectious organisms, which by sad experience we absolutely know are contained in water contaminated by sewage, are not detectable by microscopic examination, or even by chemical analysis, but only by the effects produced by them in the shape of disease, so that they necessarily must have the very minutest proportions. This being the case he reasons that there is no ground for assuming

that they or their morbific properties are destroyed by passing through the soil; but that there is, on the contrary, a very great probability that they find their way with the subsoil water into the stream at last. The only condition, under which this danger would absolutely not exist, could be, if the decomposition of these germs was effected during their passage through the soil, and their constituent elements assimilated or absorbed by it. But the decomposition in water of the organic matter of sewage is a very slow process, and the power of soils to assimilate or absorb the products of such decomposition is limited. The very fact now of the presence of the nitrates and nitrites in the subsoil water, proves that this limit is reached, so that the conclusion is almost unavoidable that in that case the minute germs referred to are present in the water at the same time.

It must be said in favor of this theory of Captain Liernur, that the River Pollution Commission take very much the same view of the matter. In their memorandum, No. 3, as to the purity of drinking water, public attention is called to the fact that water once contaminated by excrementitious matter, even in the minutest proportion, is liable to retain intensely infective properties. They warn especially against such waters, when flowing from the surface and upper strata from soils, and give as a reason for this warning that the presence of the infective matters or organisms, which in such cases is unavoidable and unpreventable, cannot be discovered by previous examination, but only by its influence on man.

The important fact that science utterly fails to detect the presence of the dangerous germs or organisms, shows what little significance, in a sanitary sense, can be attached to the clear appearance, etc., of the effluent water of sewage farms, to which the advocates of that method point with so much triumph.

It is also instructive to compare the clumsy way of treating contaminated liquid with the method adapted by Captain Liernur. The putrescible matter is, long before the period of fermentation, cut off from all contact with the atmosphere, and never sees daylight any more until it has become a harmless dry powder. This process occurs *in vacuo*, so that if there were any germs of disease in it they are by that very reason deprived of the most important factor for their vitality—namely, air. They are next submitted to the killing agency of the sulphuric acid, which Captain Liernur adds to the putrescible matter to prevent the formation of ammonia, and, finally, they are exposed to the heat of the drying process, which being 230° Fahr., effectually destroys the last principle of life.

How different from this is the process of irrigating land with the sewage containing the excreta of a town. It is then, as we have shown, unavoidable that germs of disease are imparted to the atmosphere and to the affluent water, both of these thus becoming the means of conveying these germs elsewhere; and we cannot but suspect that the frightful increase of excremental pollution diseases which have been noticed ever since we took to the system of discharging excreta into our sewers, and spreading them over marshy land and the surface of streams (such substances being specifically lighter than water), is due, among other causes, to that very method of contaminating the air we breathe and the water we drink.

In view of the great probability, as shown above, that irrigation farming is connected with great sanitary danger, and in view of the fact, that in most cases it is only a source of additional expense to

towns, it is not to be wondered at that our most eminent engineers prefer to discharge the whole of the sewage at once in the sea, whenever there is any chance of doing so at all.

For this purpose they do not hesitate to construct conduits of the costliest character and of gigantic length, rather than to try to solve the problem by means of the many new complications and financial drawbacks involved in irrigation farming.

This circumstance shows not only how low an estimate the best authorities on the subject put on the irrigation process as a means of treating the sewage of our present system, but also how very hopeless of success they consider the extraction of the manurial elements at all. This is, as we have shown, exclusively due to their enormous dilution.

In Captain Liernur's system there is no such difficulty. His *poudrette* is not made from sewage (solids or fluids), such as we know them, but from fæcal matter and kitchen waste, diluted at the utmost with a quantity of water equal to the weight of these substances.

Then again, the process of obtaining the *poudrette*, without any loss of organic matter, is not an impossibility, such as is the case with precipitation processes, but is eminently practical. It consists in distillation, which in his method means only the evaporation of a limited quantity of water. And, finally, the cost of the process is nothing, or but very little more, than that of collecting the raw material, this collection itself being accomplished by the cheapest agencies we have—namely, air and steam.

Compared with the sewage of our present system, when considered as a manure, the *poudrette* has, however, still other advantages.

The diluted liquid sewage is too bulky to be applied anywhere but in the vicinity of the town which produces it; it can be applied to nothing but irrigation fields, and it must be applied whenever it is received, in rain or in sunshine, in season or out of season, and in whatever degree of concentration or dilution it happens to be, unless, indeed, the farmer has the power of pouring what he does not want into the next stream. These are, we think, sufficient reasons why the farmer cannot afford to pay anything worth mentioning for sewage.

The *poudrette*, on the other hand, is constant in its constituent elements; is always in the same high degree of concentration; can be applied to any crop; and kept any length of time without spoiling. The farmer can buy it when most convenient to him, and use it when most advantageous. When in connection with this it is remembered that the substances, of which the *poudrette* is the residue, have an original average value of fully ten pounds per head per annum, being the food of man, and that this *poudrette* contains a great part of their nitrogenous and mineral elements, none of them being lost during the drying process, it is not difficult to comprehend how it is, that as long as guano is worth twelve pounds per ton, the product in question must have a value of ten shillings per head per annum.

With such a resulting income, the system becomes at once safe as a financial undertaking. In fact, it is the only system that pays for itself. This is evident when the annual value of the *poudrette* is compared with the cost of construction and annual expenses.

From the report of the Director of Public Works at Amsterdam, of this year, to the Mayor and Aldermen, on the sewage of that city, we learn that the average cost of the pneumatic system was not quite two pounds ten shillings per inhabitant; this sum paying all royalties, engi-

neering, plant, machinery, and other necessary works, including all changes in the houses.

The build of Amsterdam being substantially the same as that of our English towns, there is no reason why the cost with us should be more; but in order to be on the safe side, we will assume that it would be four pounds, though there is really no reason for this increased cost.

This sum we will apply to a population of the average density of seventy five persons per acre, and assume the town area to be two hundred and fifty acres. The total population would then be eighteen thousand seven hundred and fifty, and the total cost of the works seventy-five thousand pounds.

It will be readily seen, therefore, that the cost of sewering a town is pro rata in accordance with the population; and the productive power of the first outlay always remains the same per head, whether the population be two thousand or twenty thousand or even one million, the first outlay being always definitely calculated from the population.

Using the figures and proportions given by Captain Liernur, the following would be the estimate of working expenses per day:

Coal.—Power of air-pump engine required, 80 indicated horse-power. Consumes, at 5 pounds per horse-power per hour, in 12 hours, 4,800 pounds coal. Of the caloric due to this there is converted into work 8 per cent, or caloric due to 384 pounds, leaving the calories of 4,800 — 384 = 4,416 pounds, on hand for evaporating purposes. There is, however, to evaporate, 54 ounces per day, for 18,750 persons, making 63,281 pounds water, requiring, with drying apparatus, *à double effet* $\frac{6\,3\,2\,8\,1}{1\,2}$ = 5,273 pounds of coal, for which there is left the above 4,416. There is hence wanted 5,273 — 4,416 = 857 pounds, additionally to the 4,800 pounds of the air pump engine, making in all 4,800 + 857 = 5,657, or say 2½ tons of coal per day, which at 25*s.* per ton, gives	£3	2*s.*	6*d.*
Oil	0	4	0
One machinist and eleven laborers	2	0	0
Administration, repairs, and sundries	0	13	6
	£6		
Making per year, £6 × 365	£2,190		
To this would have to be added:			
For interest on capital of £75,000 borrowed from Local Board, including redemption, at 4 per cent per annum ... £3,000			
For renewal fund of machinery, at 8 per cent on £3,000 ... 240			
	£3,240	0	0
Total expenses	£5,430	0	0

The income would be, however, the *poudrette* manure of 18,750 persons, which, at 10*s*. per head, gives annually the sum of £9,375, leaving, after deducting above expenses, nearly £4,000 annually as clear profit, after paying every charge.

Should cavilers at this estimate object that the arrangements provided by Captain Liernur for preventing the dilution of the kitchen waste and excremental matter were unable to effect this to such an extent as here assumed, and that there would be for this reason a great deal more water to evaporate than above calculated upon, it is easily shown that even if this objection were well founded such would by no means prevent the system paying all its own expenses.

Supposing, for instance, that this item were double the amount Captain Liernur calculates upon, and that thus not 63,281 pounds but 126,562 pounds of water had to be daily evaporated, the quantity of coal required would then be $\frac{126562}{12} = 10.546$ pounds, of which the unused calories of the engine contribute as before 4,416 pounds. There would be, hence, 10,546 — 4,416 = 6,130 pounds required, in addition to the 4,800 pounds primarily consumed by the engine, making 10,930 pounds, or 4.87 — 2.5 = 2.37 tons per day more than first calculated. This makes 865 tons per annum, which, at 25*s*. per ton, gives £1,081. This extremely unfavorable supposition, for which there is not one good ground, would therefore only result in diminishing the clear profits from £3,940 to £2,869.

Astonishing as this result may be to many (it was so to us at first), there is no doubt as to its correctness. Nothing is easier than to convince oneself of this fact, as it is not at all necessary to take any of Captain Liernur's statements, or conclusions, or calculations, for granted.

There are but three factors to be considered in the question, namely: the cost of applying the system; the number of pounds of water which can be evaporated in vacuo by one pound of coal, when using steam *à double effet;* and the commercial value of the manurial product obtained.

For the first factor we have used an official statement, based upon the result of actual executed works; and this we nearly doubled, so that there is no danger of being deceived there.

For the second factor we have the experience of every sugar manufacturer. They employ precisely the same principle of evaporation as Captain Liernur; and it is well known that they deem the evaporation of twelve to fourteen pounds of water by one pound of coal not at all an astonishing performance. Every one of our readers can ascertain this for himself.

For the third factor, the means of testing the calculations are not less within our reach. Nothing more is required than to take some fresh fæcal matter, mixed with the proper proportion of urine, and with a quantity of slush out of the kitchen sink, about equal in weight to the solid excrements used, then add about one per cent, by weight, of sulphuric acid, and to place the mixture over a slow fire in order to evaporate the water from it, taking care not to burn the matter. The product obtained can then be taken to the nearest chemist for analysis, or, in order to be quite sure, be divided among half a dozen, so as to compare the results, and these results simply submitted to a manure merchant. By this manner, in which there is not the remotest chance of deception or error, the commercial value of Captain Liernur's *poudrette* can be very easily ascertained.

This is not written without a special purpose. We know how suspi-

cious town authorities have become on the subject of the profitableness of sewage projects. Most people have so settled themselves down in the conviction that the removal of filth can never involve anything but expense that they cannot bring themselves to believe in the possibility of anything else. But what is easier for them than to write to the municipal authorities of the cities mentioned by us as having adopted the system, for a statement of the cost of its application? What is easier than to inquire of sugar manufacturers about the economy of evaporation in vacuo, and of using the vapors of one boiling for a second one? What is easier than to make the experiment alluded to in order to get a sample of the *poudrette* on which the financial estimate of the system is based?

This being the case, it is evident that in the interest of their ratepayers it is the duty of all the sanitary authorities of towns which now suffer from defective sewerage, or are in difficulties on account of stream pollution, to take these steps to inform themselves on the subject.

Towns having already sewers on the water-carriage plan need not consider the money expended on them as thrown away, for these can be used, as formerly, for the removal of filtered house slops and rain water. But, through the application of the Liernur system for the separate removal of chamber slops, all excremental matter, and the contents of kitchen traps, in fact, all putrescible matter from households, there will be an end to the pollution of the soil and of the air with matter capable of generating germs of disease, which the porosity of these sewers and their ventilating arrangements now occasion. At the same time the pollution of the stream with the putrescible matter referred to will cease, and the town receive a profit-income of about three thousand pounds sterling per twenty thousand inhabitants each year, until the debt to the local Government is paid off. The profit will then be about double that amount, and remain so for ever after.

Towns having no sewers at all, but only surface drainage for the rain water, etc., with cesspools for the excreta, are in a still more fortunate position. Nothing prevents them from adopting Captain Liernur's system in its entirety—namely, his drainage arrangement, as well as the pneumatic system. They enjoy then the additional superior sanitary results which are due to the first-named part of the system. If it be objected to this that the town has in that case to pay for a double set of conduits, we need but point to the sums quoted as being clear profit on the pneumatic works. These sums, when capitalized, would be more than sufficient to pay the cost of the rain-water sewers, as a single calculation will show; and it is evident therefrom that at the utmost in that case the question is only one of borrowing a little larger sum from the local Government Board.

Captain Liernur points to still another advantage. The enthusiasts for irrigation farming insist upon it that sewage from which the putrescible matter of households is withdrawn contains still an abundance of fertilizing properties. Some even assert that sewage only becomes the better for this kind of farming by such withdrawal. We will not discuss here whether this is true or not, but must admit the justice of Captain Liernur's remark, that if it be so the application of his system insures a twofold advantage, namely, of obtaining enormous crops at sewage farming in addition to the profits derived by the sale of *poudrette*, and of conciliating those who advocate the water-carriage plan, on account of the glories and beauties of sewage irrigation. This last advantage can hardly be overrated, for it absolutely puts an end to the

war of systems and interests, thus making it easier for towns to decide what plan to adopt.

There are very few subjects upon which the minds of public bodies are more perplexed than the great sewage question, simply because during the last few years so many nostrums have been propounded that have turned out nostrums only. Hence people are tired of inquiring, and have sunk into a lethargic state, from which it is difficult to arouse them. The matter, however, is not one merely of local, but of imperial importance; and when a system like that of Captain Liernur comes forward, not upon promises as to what it will do, but pointing to what it has done, the proof of which is easily obtainable, it is certainly the duty of the sanitary government of a country thus struggling in doubt and difficulty, and nigh to despair, upon the very question, to bring about, as much as possible, by an official inquiry, a state of public mind that will enable sanitary bodies to comply with the very laws Government has made. The effect of present legislation is to force municipal bodies into measures which in so many cases have already proved futile, at immense cost to the ratepayers. The Government appointed Commissions to examine into irrigation and the A B C process, so that a similar course in regard to the Liernur system is not against precedent. We can only add that, in our mind, the long-vexed sewage problem has at last been solved, sanitarily, technically, and financially.

THE DRAINAGE OF LONDON AND PARIS.

SEWAGE SYSTEMS OF LONDON AND PARIS.

The following article presents, in a compendious form, all the most valuable points of the present drainage systems of London and Paris, especially of that of London. The works to relieve London of her sewage matter are of a magnitude incredible to one who has not visited them. In their construction they embody the experience of generations, and only that has been adopted which has borne the crucial test of time and multiplied trial. This article, written by the gentleman whose name is appended, and who likewise furnished the drawings, was prepared in accordance with suggestions furnished by myself. As the sources whence the facts have been compiled were deemed private property, had it not been for the kind coöperation of certain friends in London, I should have failed to procure them; and hence, to accomplish the task, it has cost some personal effort. But this is a trifling consideration, should the facts here exhibited serve to enable our Pacific cities to better solve the expensive problem of their sewage.

LEVI C. LANE, M. D.,
Late member of the California State Board of Health.

THE DRAINAGE OF LONDON.

Before entering into any description of the present drainage of London, it will be necessary, in order to fully comprehend the reasons for the adoption of that system, to consider the three following points:

Firstly—The general features of the London basin, or of so much of it as is drained by the London main drainage;

Secondly—The natural streams and their drainage areas;

Thirdly—The early system of artificial drainage adopted in the metropolis.

In proceeding to consider the first point, namely: "the general features of the London basin," reference may be made to Figures Nos. 1 and 2, Plan No. 2, which show general geological sections, north and south and east and west respectively, taken on the lines A B and C D, Plan No. 1. From these it will be seen that the London basin is impermeable clay, resting conformably on the chalk, beneath which the upper greensand, galt, and lower greensand are present, and these latter rest, it is generally presumed, unconformably upon the new red sandstone—the wealden, oolite, and lias being absent here.

The sections, Figs. Nos 3 and 4, show the general character of the post tertiary and recent deposits upon the general clay base of the Lon-

PLAN No. 2.

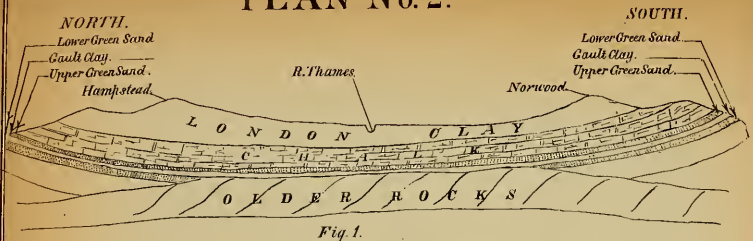


Fig. 1.

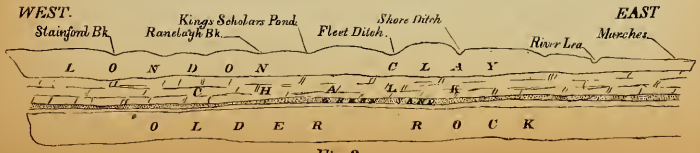


Fig. 2.

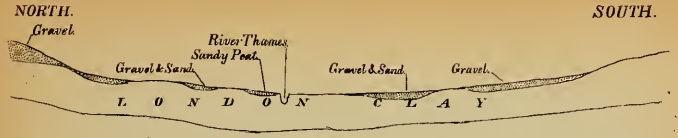


Fig. 3.

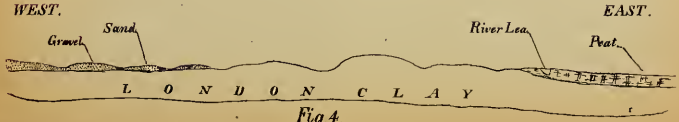
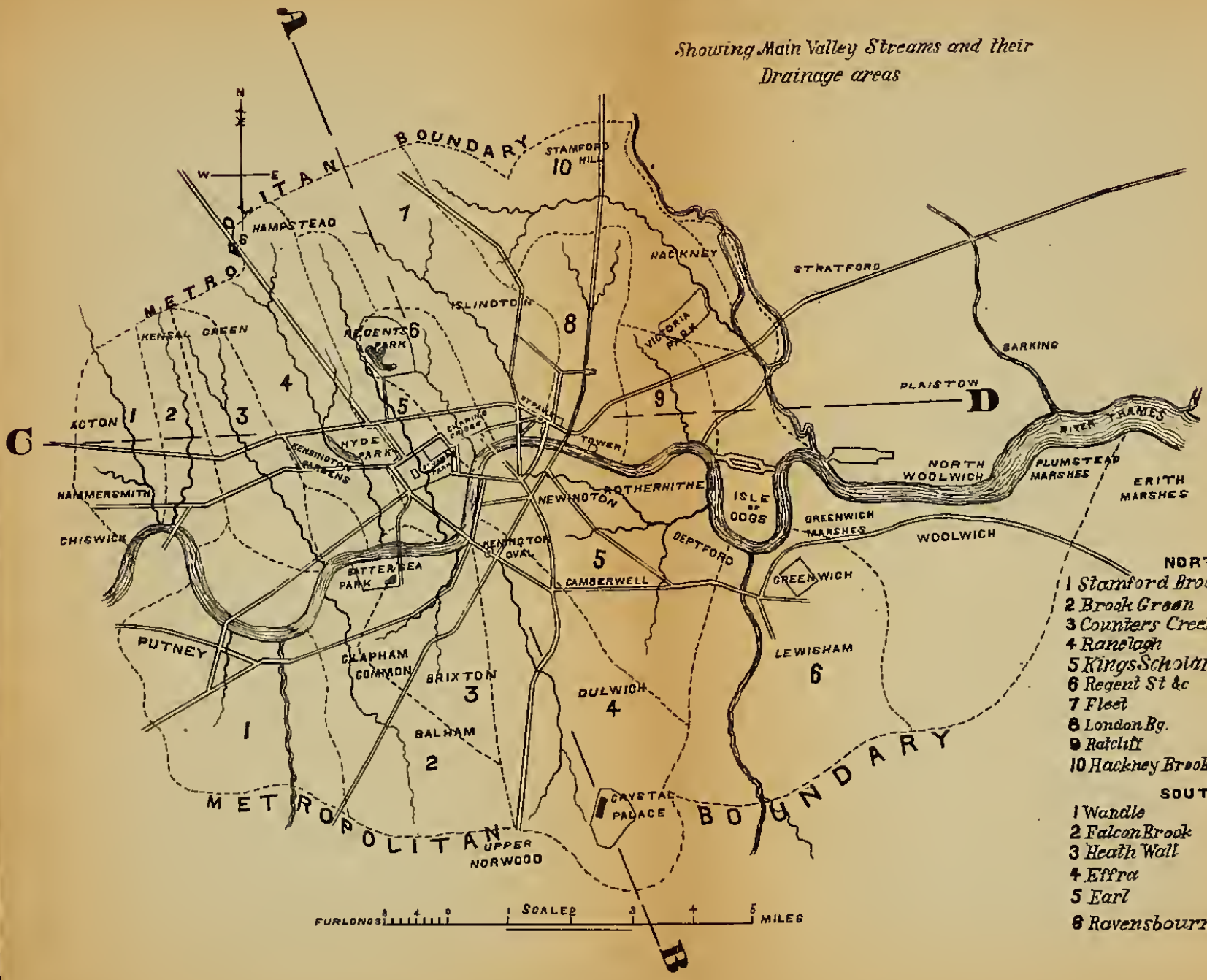


Fig. 4.

DRAINAGE OF LONDON

PLAN No 1

Showing Main Valley Streams and their Drainage areas



don basin. They are silicious iron-stained gravels, sands, silt, and peaty deposits lying in grooves or pockets parallel to the river, about twelve to fourteen feet in thickness, but occasionally, though rarely, thirty-five feet thick. They are evidently deposited by the ever changing courses of the river and its tributaries. The gravel deposits being much the older, are found frequently in the higher districts, but they presented no difficulties in the construction of the main drainage works. Not so the sand and the peat, however, as the former was generally found charged with water, in consequence of its being deposited in the impermeable clay pockets in the lower districts, thus entailing a large outlay for pumping; the latter, on the other hand, had to be removed before the foundations of the necessary works could be laid beneath it. The natural surface of London may therefore be considered to be clay, pitted and grooved by the action of the river and its streams; and many of these inequalities are filled in with sand, gravel, peat, and silt.

In the consideration of the second point, namely: "the natural streams and their various drainage areas," it is necessary that the alterations made by modern improvements be left out, and the natural streams of the basin, *pur et simple*, be dealt with.

The London basin is drained by the River Thames, which has a course through it from west to east, the country on each side gradually rising from the river, north and south, the southern portion being the flatter of the two.

Each of the main portions, viz: the northern and the southern, was intersected by several small streams running north and south from the highlands, and emptying their contents into the river after meandering through the flatter portions of its banks. These streams, and their branches, subdivide the two main areas into minor drainage areas, and collect the drainage flowing east and west. Thus, a section taken through London, and parallel to the River Thames, would present a series of undulations, as shown in Plan No. 2, Fig. No. 4, in the depressions of which flowed the various streams, or drains, emptying into the river. Many of these undulations have utterly disappeared, but the descent from Holborn and Ludgate Hills, into the Fleet Valley, and that from Piccadilly to Knightsbridge, are very apparent to even the casual observer.

The total area drained by the London Main Drainage, with which this paper deals, is ninety-nine and a quarter square miles, extending from Hammersmith on the west, to Woolwich on the east, and from Stamford Hill on the north, to Anerly on the south. This is divided, as before mentioned, into two portions, the southern having an area of forty square miles, and the northern an area of fifty-nine and a quarter square miles.

The main valley lines, or streams draining the northern portion, were the Brook Green, Counter's Creek, Ranelagh, King's Scholar's Pond, Fleet, London Bridge or Shoreditch, Hackney Brook, River Lea, and several minor brooks and drains. The drainage having been diverted from the River Lea, the area drained by it formerly, now empties its sewage into the Hackney Brook, and others.

The collecting or drainage areas of the above are as follows:

	Square miles.
Brook Green	1
Counter's Creek	2¾
Ranelagh	5
King's Scholar's Pond	3
Fleet (anciently called Holebourne or Old Bourne)	6½
London Bridge	3
Hackney Brook	7½
Minor streams, including portion of the area formerly drained by River Lea	30½
Total	59¼

The streams of the southern portion were the River Wandle, Falcon Brook, Heath Wall, Effra, Earl, River Ravensbourne, and several minor brooks, a large area being undrained. The drainage into the Rivers Wandle and Ravensbourne having been diverted, is taken directly by the new main drains.

The drainage areas of these are as follows:

	Square miles.
Falcon Brook	3¾
Heath Wall	3
Effra	8
Earl	9
Minor brooks and streams	16¼
Total	40

The low-lying grounds, as for instance, at Lambeth, Chelsea, and the Isle of Dogs, etc., were unreclaimed swamps or partially drained by small creeks and ditches.

The third point for consideration is "the early system of artificial drainage adopted in the metropolis." As habitations and streets began to spread themselves over London, it became necessary to provide some system for carrying off the rainfall from the streets by other means than that of the gutter. Brick drains were consequently laid down, leading to the nearest valley line or stream, while those nearest to the river drained directly into it. The general direction of these drains, in order to obtain a fall and to intersect the valley line, was necessarily east and west, following the dip of the land. Those in the low districts were provided with sluices or flaps to keep back the tide as it rose, and so were tide-locked for many hours. As the majority of them delivered their contents at or near low water, many portions of London, but those more particularly on the south side, were subject to constant floods. The household refuse and fæcal matter were disposed of in cesspools,

the liquid portion of it percolating through the soil, and so finding its way into the streams, and thence to the river.

In consequence of the rapid spread of population in London, it was found necessary from time to time to cover in the main valley lines. Then they were inverted, and streets were often formed upon them, but the lower portions of many of them were still left open as before.

Such was the state of the London drainage previously to the year eighteen hundred and fifteen. The ground of the metropolis was honeycombed with cesspits, which saturated it with poisonous matter, giving rise to malaria of various kinds. The higher portions of the town delivered their surface drainage into the main streams, to be by them delivered to the river, while the lower portion delivered direct into the river itself, at low water, as before described.

At about the forementioned date (eighteen hundred and fifteen), an Act of Parliament was procured, making it permissible to drain household refuse, etc., into sewers, and their management was intrusted to eight separate Commissions, each of which had a well defined district under its control, five being on the northern area, and three on the southern. Each commission being independent of the other, no one system of drainage was carried out. Thus the seeds of much evil and expense were liberally sown, by the construction of every conceivable form of sewer, without any regard to the dimensions of those into which they had to deliver, and without any consideration as to the levels of those in the adjoining districts. As the inhabitants gradually availed themselves of the opportunity of draining into the sewers, by making overflows from the cesspits or drains directly into them, the open brooks, or valley streams, became very offensive, and consequently portions of many were covered in, though for many years the Ranelagh continued to discharge into the Serpentine in Hyde Park. A few years ago it was diverted from that lake. It was then found necessary to temporarily drain it to remove the putrefying mud, and to relay the bottom with clean ballast.

In the year eighteen hundred and forty-seven, in consequence of the passing of a new Act of Parliament, the eight Commissions then existing were removed, and in their stead, a Commission for the whole of London was appointed. At the same time, the drainage of houses into the sewers was made compulsory.

The new Commission introduced the system of pipe drainage, conveying the sewage from the houses direct into the brick sewers, as well as pipes of large diameter to drain the streets, instead of the brick sewers heretofore in use. The whole of the fæcal matter was, therefore, carried into the valley lines, and thence into the River Thames.

But now the evil of the badly constructed sewers of the older Commissions began to be apparent. Many of them being large, with segmental inverts and vertical sides, thus giving the least hydraulic mean depth, and with small fall, there was little or no flow in them; and the sewage remaining stagnant, decomposition rapidly set in, giving forth its poisonous gases, until the next rainfall partially cleared it away, carrying the fœtid matter reeking to the river to enlarge its sphere of destruction.

In consequence of the connection of the house-drainage with the sewers and main valley lines, it became necessary to have tide-flaps and sluices at the outlets into the river to prevent flooding the dwellings as the tide rose. The flow, under these circumstances, was not more, even in the well constructed sewers, than six hours a day, leaving eighteen

hours during which precipitation of the solid matter could take place. The introduction of water-closets, about this time, augmented rather than lessened the evil, as decomposition was found to take place much more readily in the presence of ordinary water. The cholera, in the year eighteen hundred and fifty-four, consequent on the above state of affairs, cost London over twenty thousand lives. The river had become saturated with sewage. Parliament took up the question, and, after appointing six Commissions, without any practical result, the present Metropolitan Board of Works was formed. It is a representative body, elected from the various districts and parishes of London. Mr. J. W. Bazalgette, now Sir Joseph Bazalgette, C. B., was appointed Engineer to the Board, to carry out the main drainage of London and other public works.

OBJECTS OF THE MAIN DRAINAGE SYSTEM.

The objects sought to be accomplished by the main drainage of London are as follows:

1. To keep the River Thames, in the neighborhood of London, free from sewage at all times of the tide.
2. To abolish all open ditches and cesspools, as well as defective or shallow sewers.
3. To maintain a continual and unintermitting flow in all the sewers along their whole length, with the aid of lifts where necessary, by which evils arising from pent-up sewage, viz: the generation of noxious gases, and the unavoidable formation of deposits in the sewer during its stagnation, would be avoided.
4. To construct the sewers at inclinations, so proportioned to the volume of fluid to be carried off by each that the velocity of the current should keep them clear of deposit without the need of regular periodical flushing, which experience has shown to be not only troublesome and expensive in its operation, but also very injurious to sewers and drains in which it is practiced.
5. To form the main sewers at such a depth as not only to receive the drainage of the deepest existing sewers, but to answer the purpose of main drains capable of extension towards the extremities or borders of their districts.
6. To provide a natural escape direct into the river, by the power of gravity alone, for storm waters and land floods of the covered streams, so as to prevent any needless surcharging of the intercepting sewers with harmless flood water. Also, to construct the new intercepting sewers of such sizes only as would be sufficient to take the general drainage of their districts, including ordinary rainfalls.
7. To follow existing public streets, roads, or paths, so as to avoid heavy compensation for injury to private property, wherever this could be done, without causing injurious curves or undue prolongation of the sewers and consequent loss of gradient.
8. To provide reservoirs at the outlets of the main outfall sewers so as to be enabled to discharge the sewage at the most suitable condition of the varying tide in the river.
9. To carry off as much sewage as possible to the outfalls by gravitation alone, using the aid of steam-power for lifting the residue.

The foregoing objects have been carefully held in view, and have been practically carried out by the Metropolitan Board of Works.

From the description before given of the relative positions of the main valley lines and subsidiary drains, it will be seen that a series of

main drains laid parallel to the river would intersect the valley lines at right angles, and by being placed at varying levels as the elevation of the land increased, could be made to collect all the drainage of the districts above them, which could then be carried to the desired locality. Such is the scheme adopted.

For each of the main areas, namely: that on the north side of the river, and that on the south, similar systems of drainage are adopted. Three trunk lines, with various branches, are in each case laid down to take the sewage and ordinary rainfall, forming High, Middle, and Low Level Sewers, as shown on Plan No. 3, and receiving the drainage of the districts indicated by their names. The storm waters are, by means of overflow weirs, discharged into or dammed into the old main valley lines, and allowed to flow into the river.

In order to satisfactorily carry out this system, it was necessary to ascertain:

First—To what distance below London it was expedient to carry the sewage to be discharged into the river, in order that it might not be carried back with the flowing tides, and also at what state of the tide it was most desirable to discharge it?

Second—What is the minimum fall that should be given to the intercepting sewers?

Third—What is the maximum quantity of sewage to be carried away at any given time?

Fourth—What is the quantity of rainfall to be carried off by them?

Fifth—What dimensions should be given to them?

Sixth—What pumping power would be required, and the description of engine to be used?

Seventh—What storage would be necessary in the reservoirs?

Each of the above questions involved a considerable amount of study and experiment, and satisfactory conclusions were only arrived at after considerable labor on the part of those engaged in the research, though they were assisted by the most eminent engineers of the day.

Upon the first two points, viz: "to what distance below London it was necessary to carry the sewage," and "what should be the minimum fall given to the intercepting sewers," very much depended. As the farther down the river it was determined to go, or the greater the fall required in the sewers, the smaller would be the area which could be drained without the employment of pumping power; but it was incumbent at the same time to go such a distance as would admit of no probability of the return of any of the sewage to the inhabited portions of the town.

In order to fix upon the position of the outfalls, and the time at which the sewage should be discharged, numerous experiments were made with floats placed in the river at various times of the tides, until at a point near Barking Creek, fourteen miles below London Bridge, where the northern outfall is now situated, the following experiment was made, and recorded in a report by the late Mr. Robert Stephenson and Sir William Cubitt, in eighteen hundred and fifty-four:

"On the thirteenth of July, eighteen hundred and fifty-one, a float was put into the center of the river opposite Barking Creek two hours after high water. This time was chosen because it was found that sewage discharged into the river two hours before high water arrived at about the same point above Barking Creek as sewage discharged two hours after high water did by the next flood tide. At low water the

oat reached eleven and three quarter miles below that point, and returned with the next flood tide to one mile above it, having gone twelve and three quarter miles that flood, it being then the period of Spring tides.

"As the neaps came on, the float continued to work lower down at each succeeding high water, and by the twenty-fourth of July it was thirteen miles below Barking Creek at high water, having gone down the river fourteen miles during the falling off of spring tides to neap tides. As the floods again became stronger, it worked up the river each succeeding tide until the twenty-ninth of July, when it again came within five miles below Barking Creek at high water, having worked up the river nine miles from high water neap tides to high water spring tides, the excess of the ebbs over the floods being only five miles in fourteen days.

"Another experiment was tried at the same place on the sixteenth of August, eighteen hundred and fifty-one, it being then lowest neaps, and the float being put down two hours after high water. It worked up each succeeding high water till top springs on the twelfth of August, when it reached six and one quarter miles above Barking Creek at high water. The float then again worked down the river, till the twentieth of August, nine and one half miles below Barking Creek, being a distance of sixteen miles during the falling off of spring tides to neap tides. The excess of ebbs over the floods would in this case have been about seven miles in fourteen days. The wind and other causes would vary the result, but it may be roughly assumed that a substance in suspension works up the river about one mile a day at each high water, as the springs strengthen, and down the river two miles a day as they fall off."

From the above and other collateral evidence it was determined that Barking was the most suitable point for discharge, as the sewage would in no case be carried nearer than about seven or eight miles of London; and that the discharge should take place as soon after high water as was practicable, as it was found that the discharge at high water, at any point, was equivalent to a discharge at low water twelve miles lower down. On this account such districts as have levels that would permit of their sewage being intercepted and carried to Barking by gravitation, in order to deliver it at or about high water, are drained into the Northern High and Middle Level Sewers.

The point selected for the southern outfall is about two miles lower down than Barking on the other side of the river—namely, Cross Ness Point. The levels of the southern district differ from those of the northern in that they do not allow of the sewage being discharged by gravitation at high water, but only at low water in cases of emergency. The whole of the sewage, therefore, is in the ordinary course, lifted to the required level at the outlet.

With regard to the necessary fall to be given to the sewers; the velocity of flow required to keep them free from deposit had first to be determined.

It was ascertained by experiments that in a half filled sewer, taking the bottom velocity, various substances are carried away, as shown in the accompanying table:

LONDON
PLAN No 4

Velocity in sewer bottom in inches per second.....	Miles per hour.....	Substance removed or carried away.
3	.....	Fine clay (worked up).
6	.....	Fine sand (removed).
8	.....	Coarse sand (removed).
12	.....	Small gravel (removed).
16	$\frac{9}{10}$	Pieces of brick and stone (removed).
22	$1\frac{1}{4}$	Iron borings and slag (removed).
24	$1\frac{1}{2}$	Heavy gravel, and stones 1 in. diam. (carried away).
36	$2\frac{1}{2}\frac{1}{2}$	Stones as large as hen's eggs (carried away).

From examination of the above a minimum bottom velocity of one and a half miles per hour was considered sufficient to remove any substances likely to find their way into the intercepting sewers, and was, therefore, decided upon.

Having determined the necessary velocity, the quantity to be carried off had to be next ascertained, and, from these data, the form and fall of the sewers were then calculated so as to produce the required velocity.

London is now completely supplied with water closets, no cesspits of any kind being permitted to be constructed, and these, together with the sinks, etc., are connected with the sewers, so that almost the whole water supply finds its way into them. The sewage to be intercepted was found to be equal to the water supply, as such quantity as was lost by evaporation or waste was compensated for by leakage into the drains.

The average number of the population of the denser portion of London is thirty thousand people per square mile, and that of the outlying districts, which are wholly built upon, is twenty thousand per square mile. The water supply was taken at five cubic feet or thirty-one and a quarter gallons per head of the population per day, being an excess of about ten gallons per head per day over the actual supply at the time the observations were made, so as to leave a fair margin in case of any increase. A slight augmentation has taken place, but only of two or three gallons per head.

The amount of sewage to be intercepted in any given district was thus easily calculated. For instance, the Fleet Sewer, draining a district the area of which is $6\frac{3}{8}$ square miles, with a population of average density, would deliver about nine hundred and fifty thousand cubic feet or five millions seven hundred thousand gallons of sewage per day.

It was observed that the flow of the sewage was not uniform, in consequence of which a considerable staff had to be employed for a long period to gauge the flow over large districts. By this means not only was the sewage flow ascertained, but the effects and quantity of ordinary rainfall and floods were also made known.

From these observations it was established that one half of the ordi-

nary daily sewage of the metropolis passes in from six to eight hours, and between nine o'clock A. M., and five o'clock P. M. Provision was therefore made for the maximum case, namely: one half the flow in six hours, leaving a large margin to meet any extraordinarily rapid flow that might take place. To this had to be added the rainfall, and this question evoked much scientific discussion. While it was maintained by some that the whole of the rainfall should be taken by the intercepting sewers, by others it was held that the rainfall should be dealt with separately. But the objections to both of these schemes were many and well founded.

If the whole of the rainfall had to be intercepted, provision must have been made for storms, during some of which as much as two inches fall in an hour over nearly the whole of London. Sewers capable of taking so enormous a quantity, in addittion to the ordinary sewage, would be very costly, and for nearly the entire year would be carrying only a shallow stream of sewage in the bottom, and would consequently require a much greater fall to keep the solid matter in motion. Enormous pumping power would also have to be provided to meet such cases of flood, but which would stand idle for nearly the whole of the year.

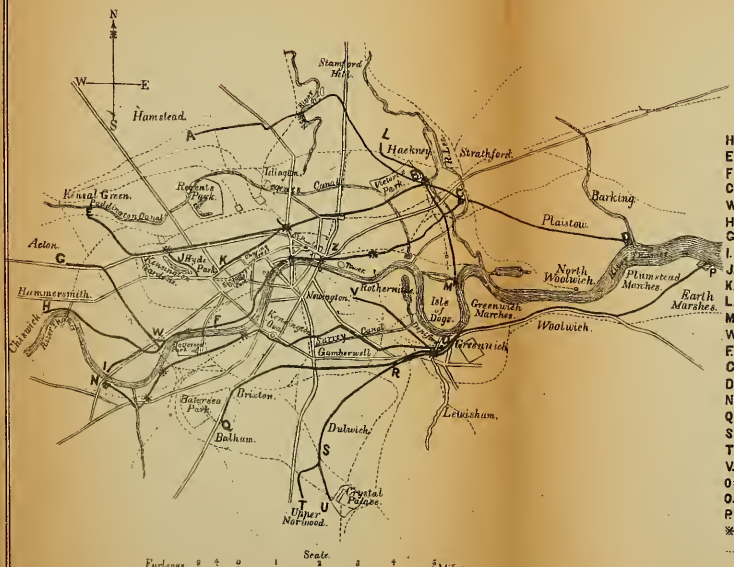
Much may be said in favor of the scheme for separating the rainfall from the sewage by a distinct series of drains, and, in the case of draining an undrained town, it would no doubt be the best system to adopt, as the rain-water drains might be built over the sewers. But in the case of London, which had its street and main valley lines already constructed, it would have been almost impracticable, as it would have entailed the redraining of the whole town at a cost too great to be contemplated. Consequently, "Object No. 6," to provide only for the sewage and ordinary rainfall, as previously enumerated, was strictly borne in mind in the carrying out of the new sewer works.

In determining the amount of rainfall to be intercepted, it was ascertained that rain falls in London on about one hundred and fifty-five days during the year, and of these there are only twenty-five on which the fall exceeds one quarter of an inch, or at the rate of one hundredth part of an inch per hour for twenty-four hours. A large portion of such falls is evaporated and never reaches the sewers, as it was found, from the observations and gaugings before alluded to, that from a rainfall of one quarter of an inch only one eighth of an inch reached the sewers; from four tenths of an inch only one quarter inch reached them, and often sensible amounts of rain fell without adding in any perceivable manner to the sewage. The amount of rainfall which it was, therefore, decided to intercept, or carry away in the intercepting sewers, is one one hundredth of an inch per hour, equal, if taken over a whole day, to a fall of one quarter of an inch in a day. This quantity, being equal in volume to the maximum sewage flow during any similar period of the six hours mentioned, would occupy an equal space in a sewer, but during the remaining eighteen hours of the day, the sewage having decreased in quantity, additional space would be left to carry off any rainfall, should it be necessary. Consequently, a sewer capable of carrying off twice the maximum sewage flow, with the safety margins already mentioned, was adopted throughout the main drainage system.

As only from fifty to sixty per cent of the actual rainfall ever reaches the sewers, they are, therefore, capable of taking an absolute fall of from three fifths of an inch to one half an inch in a day, and there are not more than about twelve days in the year on which the fall is in excess of this. The ramifications of the feeders or street sewers, and their

LONDON MAIN DRAINAGE.

PLAN No. 3.



H to B. Northern high level sewer
E .. B .. Middle .. ..
F .. C. .. Low .. ..
C .. D. .. Outfall ..
W .. F .. Low level extension.
H. Western drainage main line.
C. .. .. .. Acton branch
I. .. .. .. Fulham ..
J. Ranelagh overflow
K. Piccadilly branch middle level.
L. Hackney .. low ..
M. Isle of dogs .. .. ..
W. Cremorne pumping station (temporary)
F. Western .. .. ..
C. Abbey mills .. .. ..
D. Barking reservoir
N to Q. Southern low level sewer
Q .. O .. High .. ..
S .. O. Effra branch .. ..
T .. U. .. .. Extension
V. Bermondsey low ..
O to P Southern outfall sewer
O. Deptford pumping station
P. Crossness .. .. & reservoirs.
※ Storm outlets.
..... Railways

varying distances from the intercepting lines, allow a large quantity of the rainfall, in the districts immediately surrounding the latter, to pass off before that from the neighborhoods comparatively close reaches them; thus, as it were, spreading a given rainfall over a period considerably in excess of that in which it actually takes place.

Having decided the necessary velocity to be given to the sewage, and the amount to be carried away, the minimum fall of two feet per mile and the various increasing areas to be given to the sewers as each main line was tapped, were easily calculated from some of the most authoritative formulas.

The form of sewer adopted is circular or segmental, when the flow is large, and egg-shape for the smaller branches, which gives the greatest hydraulic mean depth for the dry weather flow.

At the junction of the valley lines or main sewers with the intercepting sewers, or at some other convenient point in their course, weirs are formed, over which any storm water is allowed to flow when it exceeds that quantity which each district drained by such main sewer should contribute. This storm water then passes into its natural channel, or old sewer, and is discharged into the river direct, thus preventing the overcharging of the intercepting sewers. By the time the water has risen to the level of the weirs the sewer itself has, as a consequence, been well flushed by the extra storm water, and all the flushings have been carried into the intercepting sewer. Therefore, such of the remainder as may flow over the weir into the river can contain little or no sewage matter. The valley lines and main sewers are, as has been previously explained, simply the two old ditches and watercourses straightened and covered in. They are, consequently, of ample area to convey the largest storm flood to the river, as they were not reduced in dimensions before being covered in.

The dimensions of the existing outlets of some of the principal valley lines are as follows:

Counter's Creek—Nine feet six inches by nine feet.
Ranelagh—Nine feet by nine feet.
King's Scholar's Pond—Thirteen feet by twenty feet.
Fleet—Fourteen feet by twelve feet.
Regent Street—Six feet six inches by five feet.
Hackney Brook—Six feet in diameter.
Falcon Brook—Eight feet by eight feet.
Heath Wall—Nine feet by nine feet.
Effra—Fourteen feet six inches by ten feet.
Earl—Ten feet in diameter.

The class of engine decided upon as the most advantageous and economical under the required conditions of comparatively small and varying lift, is the condensing double-acting rotative beam engine, working solid plunger or force pumps, directly from the beam.

DETAILS OF THE MAIN DRAINAGE SCHEME.

The northern and southern divisions of the metropolis differ considerably in their levels and physical aspect. Consequently, although the same general drainage system is carried out in both, yet there is a large amount of diversity in many of their features. The main object has been to remove as much of the sewage as possible by gravitation. To this end the northern division is divided into four drainage areas—the

High, Middle, Low, and Western Districts. The High and Middle Districts include all that area which can be drained by gravitation alone and delivered at about high water level at the outfall. The high and middle level sewers and branches performing this duty are shown on Plan No. 3, and forming a junction at Old Ford, are continued in the northern outfall sewer down to Barking.

The Low District includes all that area which can be drained by pumping the sewage a height of thirty-six feet into the northern outfall at Abbey Mills. This is performed by the low level sewer and branches and the Abbey Mills pumping engines.

The Western District includes all that which can be drained by pumping the sewage a height of eighteen feet into the low level sewer at Pimlico. This is done by the Western District sewers and Western Pumping Station; and the sewage, after flowing by gravitation down the low level sewer to Abbey Mills, is there again lifted into the northern outfall sewer, together with that of the Low Level District. The northern outfall sewer takes the whole of the northern sewage by gravitation to the reservoirs at Barking, where it can be discharged at the proper time of the tide.

The Southern Division consists of three drainage areas—the High, Middle, and Low. The High and Middle Districts include all that area which can be drained by gravitation alone, and delivered at or about low water level at the outfall. This is done by the high level and Effra branch sewers (corresponding to the high and middle level sewers of the Northern Division), which join at Deptford and flow into the southern outfall sewer at that point.

The Low District includes all areas which can be drained by pumping the sewage a height of eighteen feet, at Deptford, into the southern outfall sewer. This is performed by the low level sewer and branches and the Deptford Pumping Station.

The southern outfall sewer takes the whole of the southern sewage by gravitation from Deptford to the pump well at Cross Ness Pumping Station, where it is lifted into the reservoirs, to be discharged into the river at the proper time of the tide.

The following table shows the areas of each of the districts drained by the main lines and branches, and also their ruling gradients, dimensions, etc.:

TABLE, SHOWING—

Name of district, or sewer line.	Drainage area in square miles.	Fall of sewer.	Shape of sewer.	Dimensions from commencement. Feet.	Dimensions at termination. Feet.	Length in miles.
Northern Division.						
High level	9¾	1 in 71 to 5 ft. per mile at lower end.	Circular.	4 feet.	9.6x12.0	7
Middle level			Segmental.			
	17¾	17½ ft. per mile to 2 ft. per mile at lower end.	Egg shape.	4.6x3.0		9½
			Circular.	10.6		
			Segmental.		9.6x12.0	
Piccadilly Branch		4 ft. per mile.	Egg shape.	4.0x2.6	4.0x2.6	2
Low level	11	3 ft. to 2 ft. per mile.	Circular.	6.9	10.3	8¼
Branches						4
Western division and low level extension		2 ft. per mile.	Circular.	6.9	6.9	1½
Chiswick sewer		4 ft. per mile.	Egg shape.	4.0x2.8		3¼
	21		Circular.		4.6	
Branch sewer		10½ ft. per mile.	Egg shape.	3.9x2.6	4.6x3.0	1
Acton Branch		4 ft. per mile.	Egg shape.	3.9x2.6	4.0x2.8	1½
Outfall sewer	Above ground.	2 ft. per mile.	Segmental.	Two, 9x9	Three, 9x9	4½
Southern Division.						
High level		53 ft., 9 ft., and 2⅔ ft. pr. mile.	Egg shape.	4.6x3.0		7
			Segmental.		10.6x10.6	
Effra Branch and branches	20	30 ft. to 2⅔ ft. per mile.	Circular.	7.0x4.0		7½
			Segmental.	10.6x10.6	10.6x10.6	
Low level		4 ft. to 2 ft. per mile.	Circular.	4.0		10
	20		Segmental.		Two, 7x7	
Bermondsey Branch		4½ ft. per mile.	Circular.	5.0	5.6	2
Outfall sewer		2 ft. per mile.	Circular.	11.6	11.6	7¾

The High Level Sewer commences by a junction with a portion of the Fleet Sewer, near Hampstead Hill, intercepting a portion of the drainage of that sewer, and that of the Hackney Brook, etc. It passes under the North London Railway, Great Northern Railway, New River, and Sir George Duckett's Canal, etc., to a junction with the Middle Level Sewer at Old Ford, where it has a storm overflow into the River Lea. The eastern portion of the district to be drained by the sewer is very low, and was drained by the River Lea and part of the Hackney Brook. It was therefore found necessary to take the sewage into the Low Level Sewer by a branch called the Hackney Wick Branch, passing beneath the Northern Outfall Sewer, near Old Ford. The thickness of the brickwork in the High Level Sewer is nine inches in two half brick rings at the upper end, to two feet three inches in six rings at the termination.

The principal works on the line are a tunnel half a mile long; tunneling under the Great Northern Railway, which is on a thirty-foot bank; under the New River, which is likewise on an embankment; also, under Sir George Duckett's Canal, where the distance between the soffit of the arch and the water in the canal is only two feet; the top of the sewer and the bottom of the canal are formed of wrought iron girders, with plate decking covered with puddle. Many houses were tunneled and underpinned, and one is carried on girders—the basement being occupied by the sewer.

The Middle Level Sewer commences at Kensal Green, intercepting the greater portion of nearly all the principal valley lines, and passing under the Paddington Canal and Great Western Railway, over the Metropolitan Railway, under the Regent's Canal and North London Railway to its junction with the High Level at Old Ford. It has a storm overflow into the Ranelagh—also, at Old Ford and other points. The Piccadilly is the most important amongst its branches.

The thickness of the brickwork is the same as that for the High Level, viz: from nine inches to two feet three inches. The principal works on the line are four miles of tunneling on the main line, and the whole of the Piccadilly Branch, the depth below the ground surface being from twenty to sixty feet; the aqueduct over the Metropolitan Railway, which is one hundred and fifty feet span, and having only a distance of two and one half inches from the invert to the regulation height above the engine chimneys. It is formed of a circular tube, constructed between two girders, which rest on rollers at one end, where an expansion joint is provided in the sewer itself to permit of the elongation or contraction of the tube under the varying conditions of the atmosphere. In consequence of the close proximity to the engine chimneys, the whole aqueduct was built on a stage considerably above the railway, and was lowered into its place by hydraulic power. The tunnel under the Regent's Canal was completed with much difficulty, the water having once burst in on the works. Coffer dams were then used to inclose one half of the canal at a time, within which the sewer was built. The greater portion of this sewer is constructed in the gravel.

At the junction of the High and Middle Level at Old Ford, before alluded to, there is a large penstock or valve chamber, and a chamber containing overflow weirs. The penstocks are five in number and are

raised and lowered by machinery, by means of which the sewage arriving by the High and Middle Levels can in case of accident be diverted from the outfall sewers and allowed to flow into the River Lea. The overflow chamber is one hundred and fifty feet long by forty feet wide, and thirty feet high, divided longitudinally into two parts, in each of which is a trough nine feet deep, one being twelve feet wide and the other sixteen feet wide, having spaces about two feet six inches wide between the troughs and the chamber walls. The sewage flows into the troughs in each chamber, and then into the outfall sewer. In cases of storms, should more water be brought down than is to be taken by the outfall sewers, it rises in the troughs and flows over their edges or weirs down the spaces left for the purpose, and into a lower chamber constructed beneath the troughs which communicates with the River Lea.

The Low Level Sewer commences at the Western Pumping Station, Pimlico (its extension at a lower level to Cremorne will be taken under the head of Western Division), and passes, generally, close and parallel to the river; along the Northern or Victoria Thames Embankment; under the Metropolitan District Railway; under the Fleet Sewer outlet at Blackfriars; the North London and Great Eastern Railways, Lime House Canal, and the River Lea, to Abbey Mills Pumping Station. After receiving the drainage of the Western Division at Pimlico it intercepts the whole of the valley lines and sewers, carrying off all the sewage not previously taken by the High and Middle Level. It has storm overflow weirs at its junction with the valley lines, the principal of which is at the Fleet. It has two branches, viz: the Hackney Wick Branch and Isle of Dogs Branch. The latter drains a district which was formerly only a marshy island, but which from its position on the river was commercially of enormous value as a site for ship-building yards, docks, and wharves; but, being considerably below high-water level was undrained and almost uninhabitable. Now, however, it is well drained, and largely built upon.

The principal works connected with this sewer are nearly five miles of tunneling from Blackfriars to Bow. Along the Victoria Embankment it forms part of the river wall backing, carrying above it a subway for the gas and water mains. Close to Blackfriars Bridge the sewer passes beneath the Metropolitan District Railway and Fleet Sewer, the railway passing over the Fleet at a little distance. In order to carry this out, both the Low Level Sewer and Fleet had to be depressed at the crown and flattened out to maintain their areas. The Low Level was here formed of elliptical cast-iron tubes, stiffened with ribs, the railway being carried over it on cast-iron trough girders. The Fleet was diverted into two channels, over which the railway was carried. A large penstock chamber is here formed to govern the flow of the Fleet. There are four penstocks arranged in two tiers one above the other, with two penstocks in each tier. At the mouth or mouths of the sewer are large tide-flaps for keeping back the tide. This sewer is constructed almost entirely in the clay.

WESTERN DIVISION.

The sewer commences at Chiswick, passing under the Kensington Canal and West London Railway to a junction with the low level extension at Cremorne temporary Pumping Station. It has two branches, one to Putney Bridge, and one to Acton, which passes

under the Metropolitan Extension and West London Railways to its junction with the western sewer at Cremorne. The low level extension commences at Cremorne, and passes close to the river bank and along the Chelsea Embankment (where it is constructed similarly to that portion of the Low Level in the Victoria Embankment), to the Western Pumping Station at Pimlico. These sewers were constructed principally in the gravel which was generally surcharged with water. Sumps had to be sunk at different portions of the lines, and powerful pumping engines employed to keep the works clear of water, a stoneware pipe being laid underneath the sewer to convey the water to the nearest sump.

The Western Pumping Station, now nearly completed, will raise the drainage of the Western District (which is at present discharged into the river by the temporary pumping engines at Cremorne) a height of eighteen feet into the Low Level Sewer. The amount of sewage to be lifted is estimated at thirty-eight thousand gallons per minute. Four engines, of ninety horse-power nominal, making an aggregate of three hundred and sixty horse-power, are provided for this purpose. Three of these engines will be sufficient to effect the required work; one being spare, in case of repairs and accident. They are double acting high-pressure condensing engines, each working two single acting plunger pumps five feet three and a half inches in diameter, with four feet stroke. The engine cylinders are three feet one inch in diameter, with eight feet stroke. The beams are fifty-five inches deep at center, of box section, and of wrought iron riveted; being thirty feet in length between the centers of piston and connecting rods. The connecting rod of each engine works a crank shaft, upon which is secured a fly wheel twenty-four feet in diameter, having a twenty-ton rim. Starting gear is attached to the fly-wheel rim. The pump cases and suction tubes stand upon the foundations of the pump well. The suction and delivery valves (Porter's patent) are hinged, and mounted with leather. The delivery pipes are of cast iron, five feet in diameter, branching into a six-feet-nine-inch pipe, in which there is a six-feet-nine-inch stop valve or penstock, to prevent any back flow from the Low Level Sewer, should the engines be stopped at any time. This pipe is built into the brickwork of the Low Level Sewer, which is of the same diameter at this point. An escape or overflow pipe is provided from the top of the pump well into the river. It is closed with a penstock, and has double tide flaps at its outlet in the river wall. The water from the hot well is carried through snake pipes placed in the pump well, for the purpose of allowing the sewage water to cool it. It then flows back to a reservoir constructed beneath the coal vaults, to be used again when required. The boilers are eight in number, of six feet nine inches in diameter, with double flues each two feet in diameter, twenty-two feet long, and of the Cornish pattern. They are connected with a chimney stack one hundred and seventy-two feet in height, encased in a square tower in which is a winding staircase running round the stack to its top. The tower, at the ground line, is twenty-one feet square, tapering to fifteen feet square at the top. The foundations are carried down to the clay, and are formed of a bed of concrete twenty-five feet square.

An auxiliary engine, in a separate building, is also provided for cases of emergency. It is one hundred and twenty horse-power nominal, high pressure, and non-condensing. It is supplied by two boilers, similar to those already described. The pumps, which draw from a separate pump well, are of the bucket and plunger kind.

Before the sewage enters the main pump well, it passes through chambers containing open iron cages, or filth hoists, in which any large substances will be intercepted previous to the sewage arriving at the pumps. The cages are lifted by machinery into a covered passage or area below the surface of the ground, and in front of the engine house. Their contents are there emptied into trucks and carried away on a tram, to be disposed of as may be required. The filth hoists are in duplicate, one behind the other, so that one is lowered before the other is drawn up. Thus there is no interruption to the screening of the sewage.

The principal engine house is situated facing the river. Its length is one hundred and sixteen feet, and its height, from ground to ridge, seventy-one feet. It is in the Italian style, with a mansard roof. It is divided into three stories; the upper or beam floor being on a level with the beam centers of the engines; the ground floor being the engine floor; the floor beneath being for the purpose of providing access to the pumps and valves; and the basement being the pump well.

The boiler house is in the rear of and abutting against the engine house, but at a lower level, trams being laid from the coal vaults to the boiler house floor.

The coal vaults are at the side of the engine house, and extend to a wharf in the Grosvenor Canal. Cranes are mounted upon them for unshipping the coals and delivering them into trucks running on three tram lines, from which they can be shot down through openings into the vaults below.

In the rear of the boiler house there is a settling pond, one hundred and forty-two feet by sixty-eight feet and sixteen feet deep, divided into two compartments, in which the river water is allowed to settle before being used for the boilers.

The auxiliary engine and boiler house, stores, workshops, workmen's cottages, and trams are placed in convenient positions, in the rear of the engine house.

Abbey Mills Pumping Station is situated at the end of the Low Level Sewer, the contents of which, including that already lifted by the Western Pumping Station, have to be raised a height of thirty-six feet into the Northern Outfall Sewer. The maximum quantity of sewage and rainfall, about ninety-seven thousand gallons per minute, is lifted by eight engines, each of one hundred and forty-two horse power—in all one thousand one hundred and thirty-six horse-power nominal. They are placed in one engine house, cruciform in plan, two engines being in each arm. They are the same kind as those described for the Western Pumping Station, but rather more powerful. The cylinders are four feet six inches in diameter, and nine feet stroke. The pumps are double acting, three feet ten inches in diameter, and four and one half feet stroke, half the lift being performed by suction, and the other half by forcing. The beams are of cast iron, seventy inches deep at the center, and thirty-seven feet six inches long between extreme centers. The fly-wheels are twenty-seven feet in diameter, with twenty-six-ton rims. The pumps deliver through cast-iron pipes and a ten-foot six-inch cast-iron culvert into the Northern Outfall Sewer. There are sixteen boilers, in two boiler houses containing eight each. They are of the Cornish pattern, eight feet in diameter, thirty feet long, with two tubes in each, three feet three inches in diameter, delivering through brick flues into

two chimney shafts, each of which are two hundred and nine feet high, and eight feet internal diameter, with foundations carried down to a depth of thirty-five feet. Trains connect the boiler house floors with the coal vaults. The engine and boiler houses are attached to each other, their extreme dimensions being one hundred and forty-two feet six inches. The width of the arms of the cross is forty-seven feet six inches. Each of the boiler houses is one hundred feet by sixty-two feet. The center of the building is covered by a dome, the total height of which is one hundred and ten feet. The style of the building is a mixed Gothic. The arrangements of the internal floors, the coal vaults, settling ponds, filth hoists, workshops, and workmen's cottages, are similar to those of the Western Pumping Station.

The Northern Outfall Sewer commences with a junction with the penstock chamber at Old Ford, as previously described. Here it receives the contents of the High and Middle Level Sewers. It consists of two brick sewers segmental in form—that is to say, a semicircular crown, with segmental sides and inverts, nine feet high by nine feet wide. It passes close under the North London Railway, which is carried over it on girders. From this point to the outfall at Barking, the level of the ground is very low, a large portion of it being under high-water level. Consequently, in order to deliver the sewage at high water, this sewer is constructed entirely above ground. It is laid upon concrete foundations carried down through the peaty soil to the gravel beneath. The culverts are entirely surrounded by concrete, which is carried up with a slope of one to one to give support to the sides of the sewers, the whole being covered with an earthern embankment, and fenced with hedge and ditch. Very many roads had to be raised or lowered to admit of the sewers passing under or over them. This entailed the purchase of a large amount of house property.

Amongst other works of importance, upon this line, are the following: (See Plan No. 5, Figures 1 and 2.) The aqueduct over the River Lea, which is of fifty-seven feet span, and consists of two wrought iron culverts, of the same section as the brick sewers, slung between three wrought iron plate girders. Upon the top a roadway is formed with proper parapets.

The bridge over Abbey Mill Lane consists of two self-supporting wrought iron tubes. The crossing over Abbey Creek, close to which the junction with the culvert bringing the contents of the Low Level Sewer from Abbey Mills takes place, consists of three cast-iron culverts, supported by four wrought-iron plate girders, in two spans of forty feet each.

THE LOWERING OF THE NORTH WOOLWICH AND BOW AND BARKING RAILWAYS.

For a considerable distance over the marshes, the peat was found to be of so great a depth that the cost of sinking a solid foundation would have been enormous. In lieu of this, pits were excavated six feet six inches wide, and of the full width of the embankment, down to the gravel beneath, at intervals of twenty-one feet from each other. These were filled in with solid concrete, so as to form piers, and upon them were turned brick arches, four rings in thickness; and upon these again were built the culverts and embankment, as before described. The inverts of these culverts are about eighteen inches below high-water mark at the outlets; but before being discharged into the river the sewage falls over an apron a depth of sixteen feet, whence it is carried

by nine six-feet culverts, laid in the river bed at the level of low-water spring tide. Penstocks are arranged above the apron so as to divert the sewage into the Northern Outfall Reservoir, as it is only discharged into the river within about two hours after high water.

The Northern Outfall Reservoir, which receives the contents of the Northern Outfall Sewers, is situated about eleven and one quarter miles below London Bridge. It is sixteen feet nine inches deep, and covers an area of about nine and one half acres. It is divided into four compartments, and completely covered in with brick arches on piers, and is capable of containing about thirty-nine million gallons. The foundations of the piers are carried down about twenty feet below the level of the floor, which is paved with York stone. The whole is covered with an embankment of earth. One side of the reservoir is formed by the outfall sewers themselves, which are here provided with sixteen openings, each having a penstock, so that the flow of sewage may be either turned into the reservoir or river direct, as required. Beneath these penstocks are sixteen other openings, with penstocks for the outflow of the sewage from the reservoirs into the river. These openings are connected with the nine six-foot culverts, before described, which deliver the sewage at the bottom of the river. In order to prevent the sewage rising above a certain level in the reservoir, overflow weirs are formed in the partition walls, which are built hollow, and communicate with the discharging culverts. The reservoirs can, however, be entirely filled, if required, by closing penstocks fitted to the discharging culverts.

A large culvert is constructed at the back of the reservoir, having communications with each of the compartments in the reservoirs—the openings being fitted with penstocks. This culvert communicates with the river, so that at high tide any of the compartments can be filled with water and be cleansed by being flushed out at low tide.

Any one or all of the compartments can be filled from the Northern Outfall Sewer, as may be required.

The river bank is protected by a coffer dam.

SOUTHERN DIVISION.

The High Level Sewer commences at Clapham, intercepting the principal valley line. It is constructed of sufficient dimensions to carry off the storm waters, which it discharges into Deptford Creek. The Effra Branch, corresponding to the Northern Middle Level, commences at Upper Norwood and intercepts the southernmost drainage of this division. It, like the High Level, is also of sufficient capacity to carry off the storm waters, which are discharged over a weir, with those of the High Level, into Deptford Creek.

As a very large area of this division is exceedingly low and flat towards the river, the lower lines would have been flooded if the storm waters from the upper district had been allowed to flow into them as is done in the Northern Division. Therefore, the High Level Sewer and Effra Branch were constructed to carry the storm waters as well as the sewage from the old sewers and valley lines to a new outlet at Deptford, as described. The sewage and a certain amount of rainfall are carried under Deptford Creek in four cast-iron culverts three feet six inches in diameter each, and delivered into the outfall sewer.

The principal works on these lines are the Dulwich Tunnel, one thousand feet in length; the double sewer along New Cross Road, which is about one thousand one hundred and thirty feet in length, each culvert

ten feet six inches by ten feet six inches, segmental in form. In excavating for these sewers a large quicksand was encountered, which caused considerable expense and delay. The method adopted of withdrawing the water without drawing of the sand was first to sink, in some convenient position near to but not in the intended works, a brick well, to a depth of five or six feet below the lowest part of the excavation. In some cases where the depth was great, an iron cylinder was sunk below the brickwork, and the bottom and sides of the well were lined with shingle, which filtered the water passing into it, and exposed a large surface of this filtering medium. Earthware pipes were carried from this well and laid below the invert of the intended sewer, small pits being formed at the mouths of these pipes to protect them from the deposit. (Plan 5, Figure 3.) By these means the water has been successfully withdrawn from the worst quicksands, and they have been rendered firm and dry for building on without any subsidence of the ground above them. Iron plates have in olden times been laid underneath the brickwork of the invert of the sewers to support them in such treacherous ground, but concrete is now wholly used, and forms both a better and a cheaper foundation, and unless the ground is so dry and solid that it can be excavated to the exact form of the sewer to be placed on it, there is no portion of the work more important than the effectual backing of the invert and the haunches with concrete.

The storm outlets to Deptford Creek consist of two ten feet six inches by ten feet six inches double tide flaps, the large lower ones being fitted with locking gear. When these lower ones are closed and locked the whole of the sewage flows into the Southern Outfall Sewer, but should it rise above the lower ones it will open the small upper ones and flow into the creek. The lower flaps can be unlocked so as to let the whole of the sewage, etc., into the river in case of accident. Penstocks are also fitted to the pipes carrying the sewage under the creek before mentioned, so as to shut it off from the outfall sewer. These sewers are constructed in clay toward the upper portion, and sand in the lower.

The Low Level commences at Putney, and flows through the low grounds before mentioned, but at some distance from the river, to the pump well at Deptford Pumping Station. It intercepts the whole of the main valley lines, and is provided with several storm overflows. In the low-lying grounds between the Low Level Sewer and the river the old ditches had been and the sewers were constructed with a fall generally from west to east, by which means they discharged at a lower point in the river. In order to intercept these a branch called the Bermondsey Branch was constructed from the Low Level, in a northeasterly direction, which receives the remainder of the drainage of the Earl, Battle Bridge, and Duffield Main Sewers.

The most important works upon the Low Level and its branches are:

A tunnel from Kensington Church to Old Kent Road, one thousand feet in length, carried under a very large number of houses, being only ten to twelve feet below the surface.

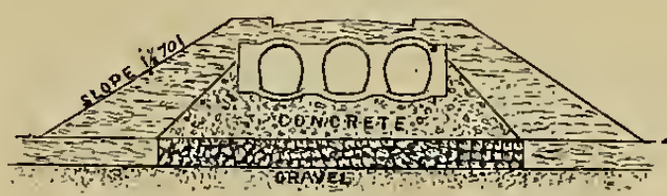
A tunnel under the Surrey Canal, the soffit of the arch being only eight feet below the water.

Also another tunnel under the same canal, where the distance of the top of the tunnel from the water was only six feet four inches, the soil being gravel and sand, and the canal having one foot of puddle in the bottom.

Several tunnels under railways, and one under Deptford Creek, where large quantities of water were met with, to overcome which two ten-

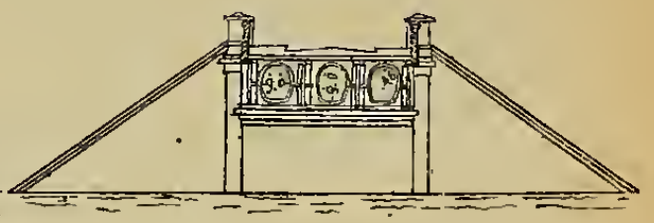
PLAN No. 5.

Fig 1.



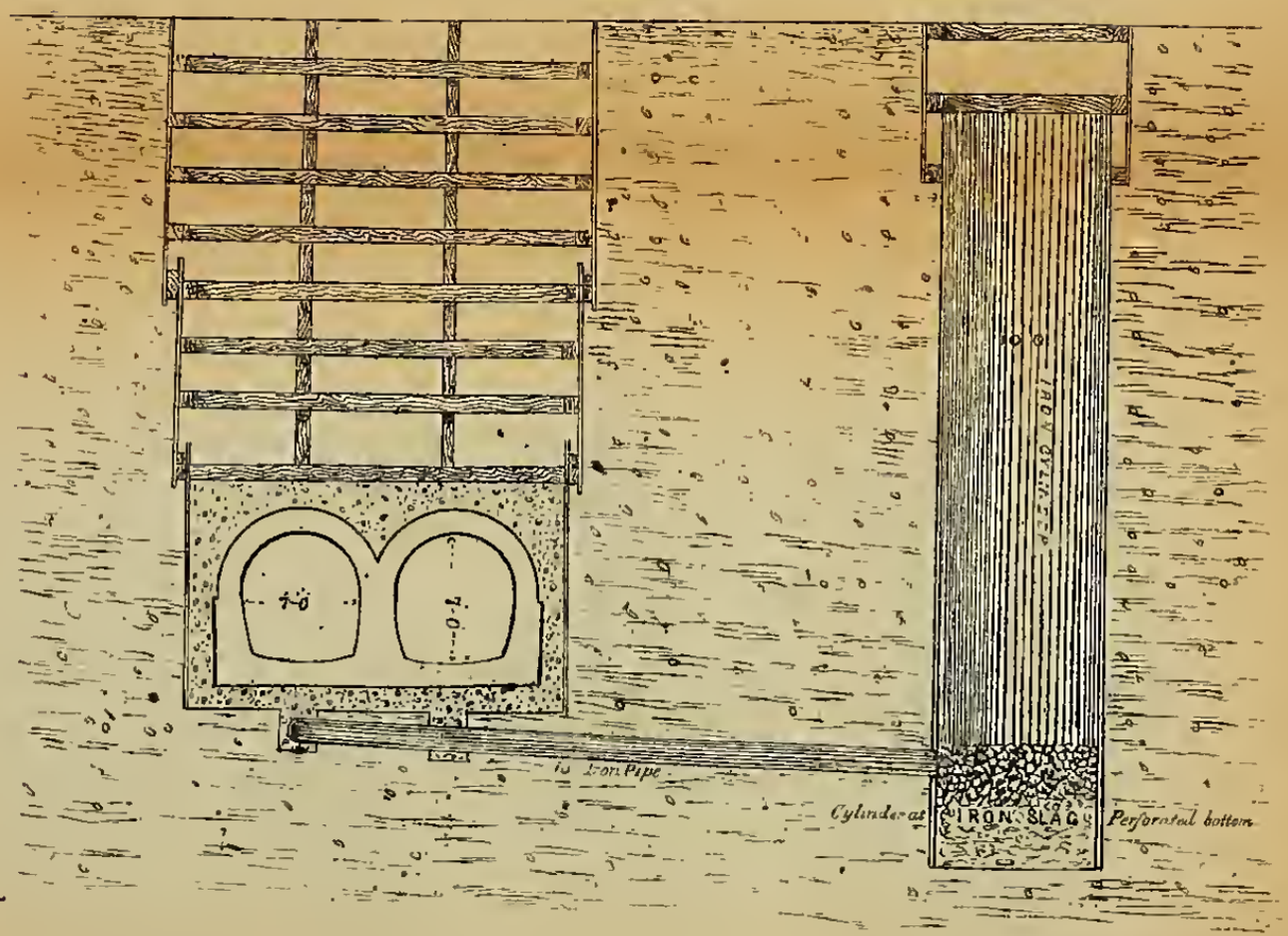
General Section of Northern Outfall

Fig 2.



Bridge carrying Sewer over Public Road.

Fig. 3.



foot cylinders were sunk through the sand in the neighborhood to the depth of forty-five feet, in the method before described, and the water was kept down by pumping at the rate of seven thousand gallons a minute. The navigation was kept open by half the river being inclosed at a time in a coffer dam. The upper end of the sewer is in clay, and the lower in gravel and sand.

Deptford Pumping Station is built at the termination of the Low Level Sewer, at the side of Deptford Creek, where a wharf is formed for landing coal for the works. The sewage is here lifted from the Low Level Sewer a height of eighteen feet, into the Southern Outfall Sewer.

The maximum amount of sewage and rainfall to be lifted is about sixty-five thousand gallons per minute, for which purpose four one hundred and twenty-five horse-power engines, of the same type as those before described, are employed, making a total power of five hundred horse power nominal. Three of the engines will usually do the work, one being kept spare for repairs or emergencies. The cylinders are four feet in diameter, with nine-feet stroke. The sewage pumps are single-acting plungers, seven feet in diameter, and four-and-a-half feet stroke. The pump valves are hanging valves, and were originally faced with leather, but India rubber is now substituted in these, and also in those at Abbey Mills and Cross Ness. The pumps deliver into a cast-iron culvert, at the end of which, at its junction with the outfall sewer, is placed a penstock, to prevent any back flow from it. There are ten boilers of the Cornish pattern, thirty feet long and six feet in diameter, with single flues delivering into a chimney shaft one hundred and fifty feet high, and seven and one half feet internal diameter at base and six feet at the top, with ornamental cast-iron cap. The foundations are of cement-concrete. The furnaces draw from the sewer on the plan adopted at the other pumping stations, which ventilates them considerably. The whole of the engines are in one building. Trams connect the boiler-house floor with that of the coal vaults.

Before entering the pump well the sewage is screened by passing through iron bar fixed gratings, from which the filth is removed by scrapers attached to an endless chain. This method is now superseded at the other and more recent stations by the movable cages before described. Other particulars of engines and workshops are similar to those already detailed.

The Southern Outflow Sewer commences at Deptford Pumping Station, where it receives the contents of the High and Middle Level (or Effra branch) Sewers, brought by gravitation under Deptford Creek, as before explained, as well as that of the Low Level, after being pumped up into it by the Deptford engines. It passes under Greenwich and Woolwich to the pump well at Cross Ness Pumping Station on Erith Marshes.

The principal work on this line is a tunnel under Woolwich, a mile long, formed in the chalk. Great difficulty was experienced in forming the foundation across the marshes where large quantities of water had to be contended with. With the exception of the tunnel this line is formed in gravel, peat, and sand. The thickness of the brickwork is eighteen inches, and it is entirely laid in cement.

Cross Ness Pumping Station and reservoirs are situated on the south side of the river, about twelve miles below London Bridge. As is the case on the northern side, the sewage is only discharged at about high

water or within two hours of that time; but the outfall sewer is of such a level as to be able to discharge at about low water if necessary.

A penstock fitted to the outlet diverts it into the pump well through a culvert forming the lower one of a tier of three. The upper one takes the sewage from the pump to the reservoirs, and the middle one takes it from the reservoirs to the river outlet. Culverts are provided so that the sewage can also be discharged direct from the pumps into the river without entering the reservoirs.

The outlet from the outfall sewer into the river is formed of twelve cast-iron pipes, four feet four inches in diameter, carried under the fore shore into the bed of the river; in front of their mouths is a paved apron, the other ends being connected by a bell mouth with the sewer. The foundations for the reservoirs and buildings are carried down through the peat to the gravel, a distance of twenty-five feet.

The ordinary quantity of sewage to be lifted is about sixty-five thousand gallons per minute, but in cases of storms about one hundred and twenty thousand gallons. The lift varies from ten to thirty feet, being the least when the greatest quantity is flowing in from the outfall sewer; so that when the most power is required the lift will be at a minimum, thus lightening the engines in one way, which leaves the power to cope with the extra quantity.

There are four engines of one hundred and twenty-five horse-power each, in all five hundred horse-power nominal, being of the same type and power as those provided at Deptford. The reason that the power provided at Cross Ness is only equal to that provided at Deptford arises from the fact, that in case of a paucity of power at Deptford on the occasion of a storm, the low-lying districts of London would be flooded; but should such a case occur at Cross Ness, the outfall sewer would act as a reservoir (containing four million cubic feet, or as much as the Cross Ness reservoir), until the pumps could relieve it, without flooding any property. The engine cylinders are four feet in diameter, with nine-feet stroke. The sewage pumps are single-acting plungers, eight to each engine, and four feet six inches in diameter, four having four feet six inches stroke, and the remainder two feet three inches stroke. Any or all of them can be thrown out of or into gear to meet the varying lift and requirements. The beams are in two flitches, and are forty feet long between centers. The fly-wheel is twenty-seven feet in diameter, and weighs fifty tons. The boilers are twelve in number, and are single flued Cornish boilers, similar to those at Deptford. They communicate with a chimney shaft two hundred feet in height, and eight feet three inches internal diameter throughout, the foundations for which are twenty-five feet below the ground level.

The sewage is delivered from the pumps into a wrought iron tube discharging into the brick culverts before mentioned, and thence into the reservoir. There are two tiers of eight openings in each of the four compartments into which the reservoir is divided. The upper tier is for the inflow of the sewage from the pumps, and the lower for discharging into the river. All of these are fitted with penstocks.

The reservoir covers six and a half acres, and is seventeen feet deep, and capable of holding four and one third millions cubic feet of sewage. It is covered in with brick arches, in a similar manner to the reservoir at Barking.

The engines are in one house, one hundred and fifty-four feet long by fifty-three feet wide. The boiler house is one hundred and twelve feet long by sixty-four feet wide.

PLAN No 6

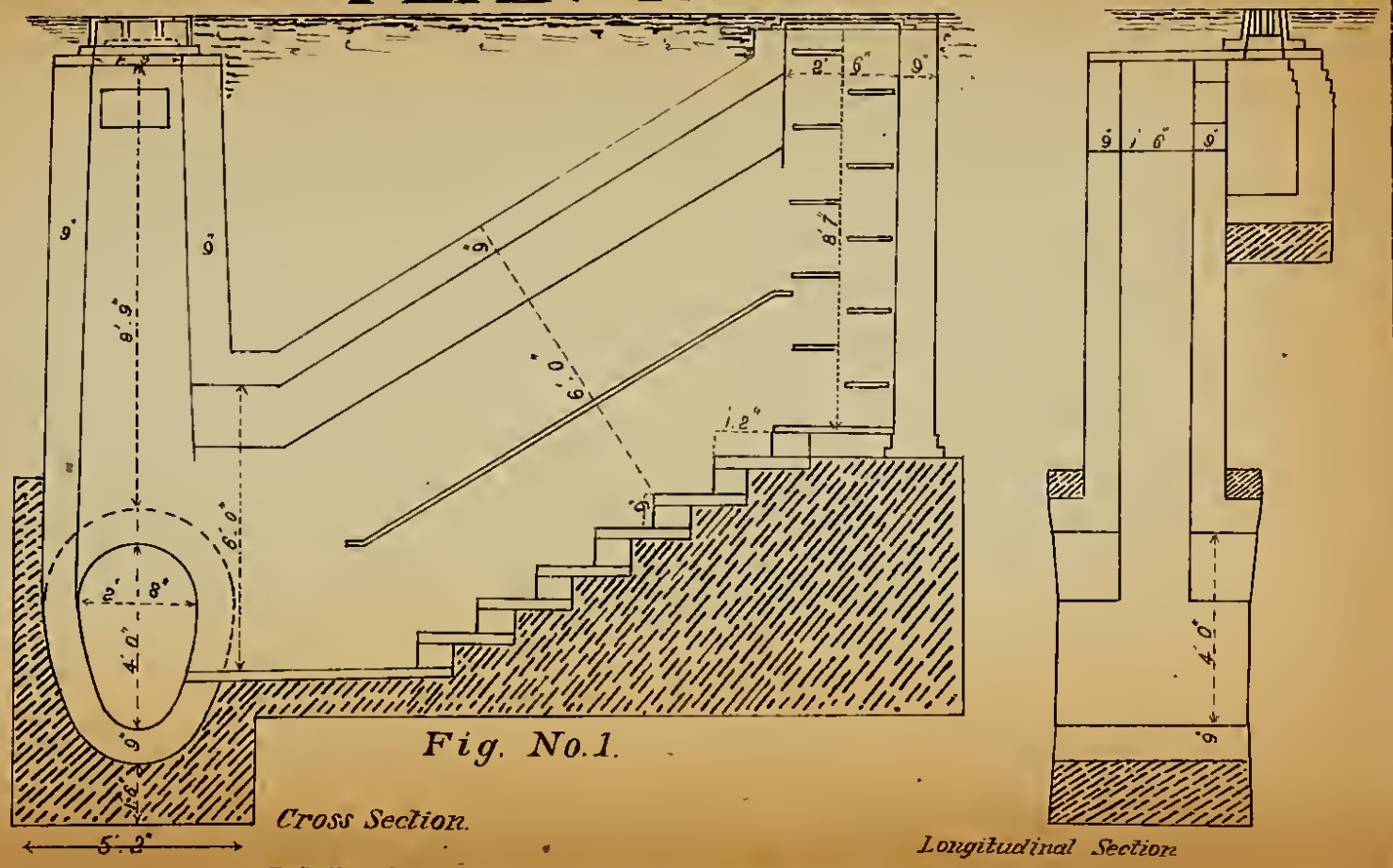


Fig. No. 1.

Cross Section.

Longitudinal Section

Details of Side Entrance. Ventilating Shaft and Catch Pit.

DRAINAGE OF LONDON

Cully Grate and Catch Pit.

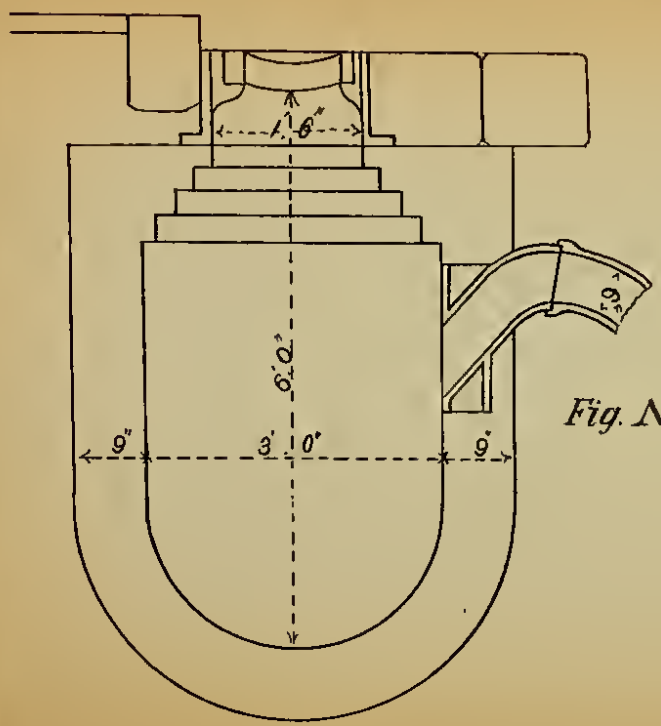
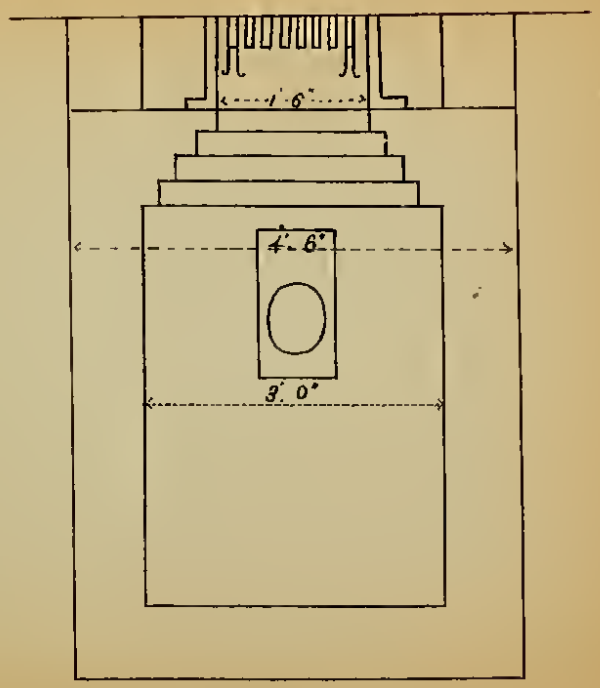


Fig. No. 2.



The filth intercepters are the same as those in use at Deptford Pumping Station. A wharf is formed along the river-front for landing coals, etc. The coal vaults communicate with the boiler houses by means of trams, which are also laid on the wharves and workshops. Workshops, cottages, a manager's house, and a school for the workmen's children, are provided and conveniently arranged.

MATERIALS USED AND OTHER PARTICULARS IN CONNECTION WITH THE MAIN DRAINAGE.

The bricks used throughout the works are the best picked stocks or Gault clay bricks. The inverts of the sewers are formed of Staffordshire blue bricks laid in cement. The whole of the lower half of the sewers is laid in cement, formed, in some cases, of equal proportions of Portland cement and sand; the upper half is laid in Lias lime-mortar containing two of sand to one of lime. Where the ground is treacherous, or the sewers are in tunnel, they are generally laid entirely in cement.

The Portland cement used was of the best quality, weighing one hundred and twelve pounds per striked bushel, and capable of supporting a tensile strain of four hundred pounds per square inch, seven days after being mixed and placed in water, during the whole of that period.

The lime concrete consists generally of six parts of clean river ballast to one part of ground Lias lime.

The cement concrete varies in its composition according to its situation, namely: from ten to six of ballast to one of cement.

The stone dressings to the buildings are of Portland stone, and the flaggings of Yorkshire stone.

The whole of the iron, lumber, and other materials are of the best obtainable quality.

The sewers are ventilated, as before noticed, by being connected with the furnaces. There are also ventilating shafts from five hundred to six hundred feet apart in nearly all the sewers. These communicate with the street after passing through a catchpit, which receives the mud that falls through the grating in the roadway, and thus prevents it from getting into the sewer. (See Plan No. 6, Figure No. 1.)

Various methods have been and are still being tried to deodorize the gases before they reach the street, but no universal system has as yet been adopted. Two of the principal methods are as follows:

By causing the gases to pass through a charcoal filter placed in the opening between the ventilating shaft and the catchpit.

By hanging, in the ventilator shaft, a long strip of flannel, which is kept saturated by capillary attraction with sulphurous acid, contained in an earthenware vessel which is periodically filled.

Both of these methods are efficacious, but troublesome and expensive. Exclusive of these purifiers there is little or no annoyance from the ventilators in the streets, and none whatever from those over the new main sewers, in consequence of the unintermitting flow in them.

Access is obtained to the sewers through shafts and passages with steps, and the entrance is closed with an ingenious double door or cover, so arranged that when men are at work in the sewers the top or solid one may be left open, while the bottom, a perforated one, is closed, thus allowing a free passage of air without any interruption to the foot-passenger traffic above. The side entrances are placed in the pavements

and have an arched way communicating with the sewers. (Plan No. 6, Figure No. 1.)

In constructing the sewers in tunnels it was found necessary, where they were not in the clay, to leave a large portion of the timbering used for supporting the sides and roof in its place, and to pack around the sewer with concrete. (Plan No. 7.)

A large number of the principal old sewers have been reconstructed, and their courses have been straightened; uniform gradients, proper sections, and improved outlets being at the same time given to them, but the cases are too numerous to mention.

The district and less important sewers or feeders are gradually being reconstructed by the district or local Boards, under whose control they exist.

Flushing gates are provided in most of them, by which, in the dry weather, the sewage is penned back and allowed to accumulate behind them, when they are suddenly opened, causing a violent rush along the sewer, and thus scouring away any accumulated matter. All these gates are worked by machinery.

Before flowing into these sewers, the rain water and washings from the streets are carried down the channel gratings into a catchpit about six feet deep. The solid matter sinks to the bottom to be removed when required, the liquid rising and passing down a syphon-trapped pipe into the sewer beneath, thus preventing the heavy sand and a great deal of the solid matter from entering them and causing deposits to take place. The gully grates are from 16 inches by 18 inches to 16 inches by 24 inches, of cast iron and of great strength, hinged to a cast-iron frame. They are placed in the side channels on both sides of the street, about eighty feet apart, alternating from side to side, or in other convenient positions, as occasion arises. All connections with the district sewers, whether from houses or street gullies, have a flap fixed at their junction to keep back the gases, or the sewage, should it rise too high in the sewer. (See Plan No. 6, Figure No. 2.)

In all of the new streets lately constructed in the denser portions of the metropolis, large subways (as in the case of the Thames Embankment) have been formed, in which are laid the gas and water mains; and it has been found convenient in most cases to construct the sewers beneath them.

The total sewage of the Northen Division is about ten and one half million cubic feet per day; the total rainfall provided for the Northern Division is about twenty-eight and one half million cubic feet per day; the total sewage of the Southern Division is about four and one half million cubic feet per day; the total rainfall provided for the Southern Division is about seventeen and one half million feet per day. Provision is made for an increase of sewage in the Northern Division of one million cubic feet per day. Provision is made for an increase of sewage in the Southern Division of one and one quarter millon cubic feet per day. Making a total of sixty-three millions of cubic feet per day. There are in all about eighty-three miles of main or intercepting drains, and about one thousand three hundred and fifty miles of other sewers.

The steam-power provided is: (1)

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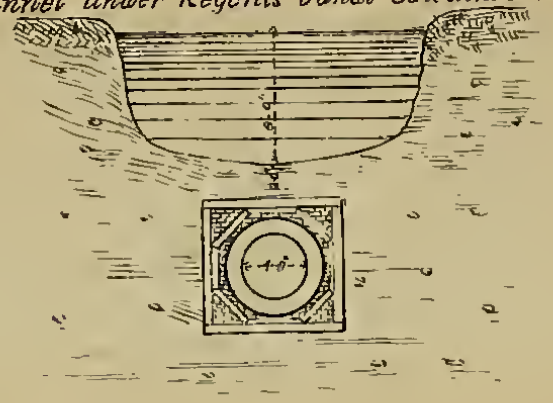
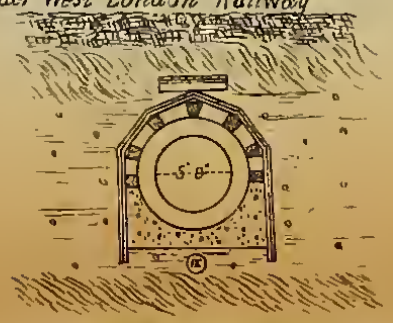
(1) Is equivalent for drainage purposes to raising the whole of the district pumped to the height of the corresponding lifts.

PLAN No 7

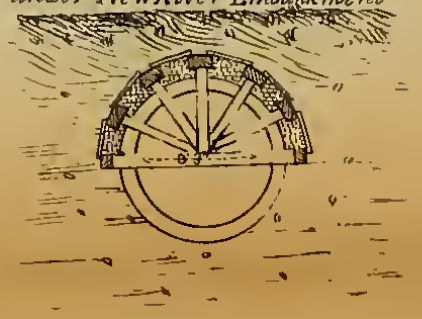
Section of Sewer in Tunnel under Regents Canal Caledonian Rd.



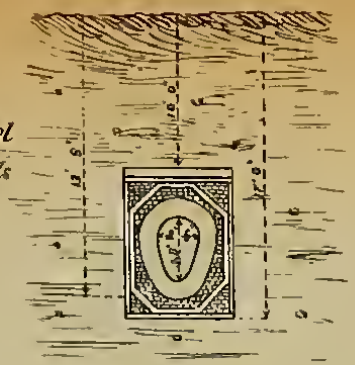
Section in Tunnel under West London Railway

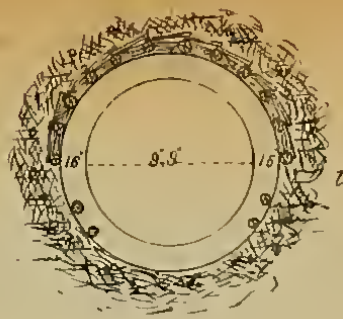


Section in Tunnel under New River Embankment

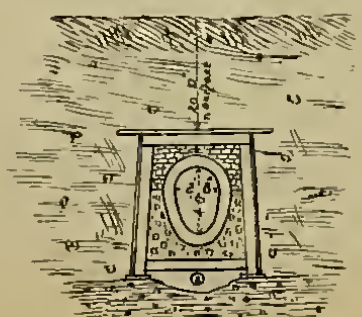


Section in Tunnel under Horse Guards

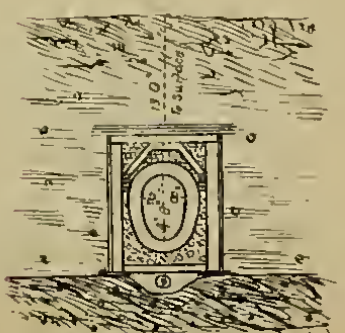




Section in Tunnel under New Inn Yard



Section in Tunnel under the Mall Hammersmith



Section in Tunnel near Hammersmith.

DRAINAGE OF PARIS.

PLAN No.8.

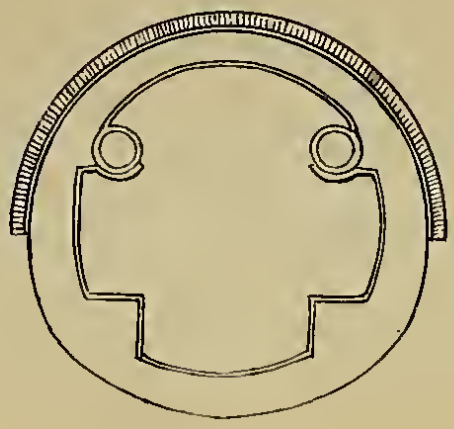


Fig. 1.

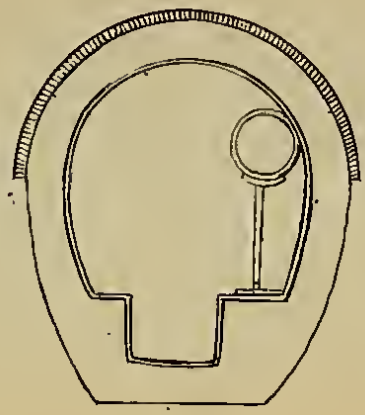


Fig. 2.

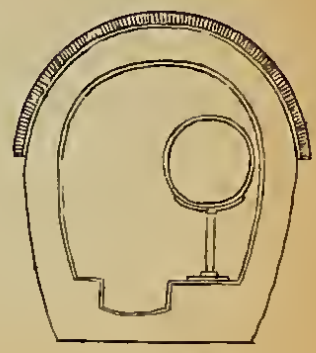


Fig. 3.

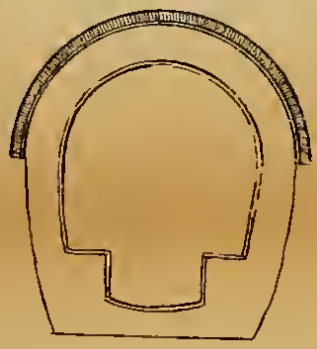


Fig. 4.

Fig. 5.

Fig. 6.

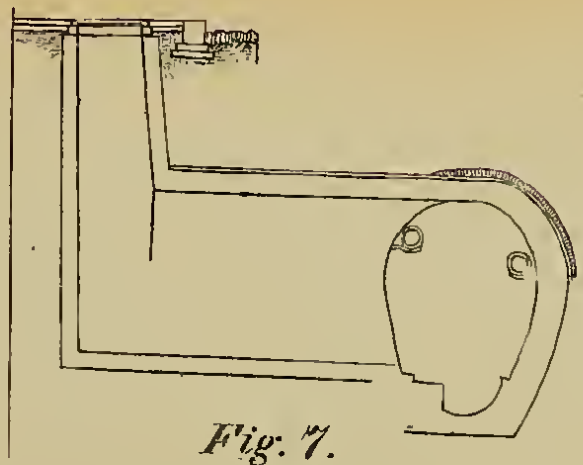


Fig. 7.

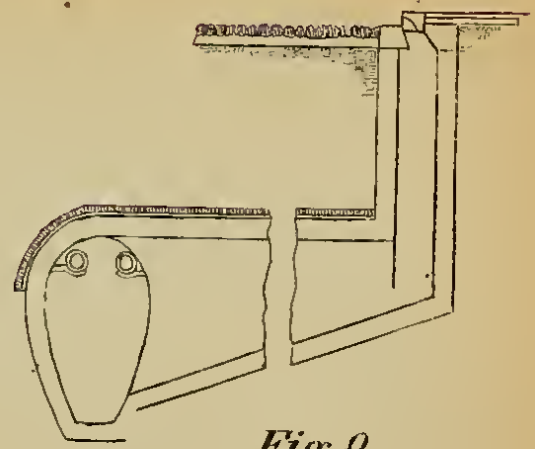
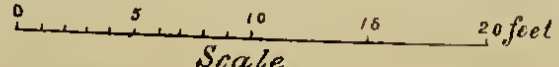


Fig. 8.



Scale.

Northern Division.	
At Western Division Pumping Station.....	480 horse-power, nominal.
At Abbey Mills Station.....	1,136 horse-power, nominal.
Southern Division.	
At Deptford Mills Station.....	500 horse-power, nominal.
At Cross Ness Mills Station.....	500 horse-power, nominal.
Total.....	2,616 horse-power, nominal.

The amount of coals that will ordinarily be consumed is about twenty-five thousand tons per annum.

The total cost of the main drainage system when complete will be about £4,500,000. Any details of cost for the purpose of comparison with similar works would be useless and misleading, as the great and constant variations in prices of materials and labor prevent any standard being laid down on which the basis of an estimate could be formed. For instance, the Cross Ness pumping engines cost in eighteen hundred and sixty-four, £90 per horse-power, nominal, whilst those at the Western Pumping Station, by the same makers, cost in eighteen hundred and seventy-two, £120 per horse-power, nominal, being an increase of thirty-three per cent. Cement concrete has varied on these works from 6s. 6d. to 11s. per cubic yard, and brickwork from £13 to £21 per rod.

Several attempts have been made to utilize the sewage brought down by the outfall sewers. The first company started with a proposed capital of £2,000,000, obtaining a concession for thirty years exclusive use of the sewage on the north side of the river, from the Metropolitan Board of Works. Its intention was to carry the sewage several miles down the river to the marshes and reclaim them, using the sewage to irrigate, and at the same time to elevate their surface. After expending about £300,000 the scheme was abandoned. The only portion of the work still in operation is a small farm of about two hundred and fifty acres, on which the sewage is used for irrigation, and, as it appears, with a tolerable amount of success.

On the south side of the river a company was started to precipitate the fertilizing matter contained in the sewage by a method known as the "A, B, C," process. A considerable amount of capital was expended in experiments and the laying out of works, but after they had been in operation about a year they also were abandoned, and since then no further attempts at utilization have been made.

In conclusion it may be remarked that it has been found necessary to construct a large sluice-gate in the Southern Outfall Sewer, as a considerable deposit of sand was found to have accumulated in it. But, whether this arises from the sewer, which is on very treacherous ground, having sagged, or that because a large area drained by it has not been provided with catchpits at the street gullies, has not been made known.

A cause of trouble has also arisen from the fact that so small an amount of sewage is carried from the Southern High Level and Effra Branch into the outfall that after a comparatively slight rainfall, the sewage escapes at the overflow in Deptford Creek in a far too undiluted condition. This gave rise to some litigation between the inhabitants and the Metropolitan Board of Works, but it has been amicably arranged.

THE DRAINAGE OF PARIS.

The Paris Basin is drained by the River Seine, which runs through it generally from east to west. The southern bank slopes gradually upwards from the river to the extremities of the city with an almost unbroken surface.

The northern bank has one slope bordering on the river, and beyond its summit there is another slope in a northerly direction down to the Brook of Menilmontant. This brook runs parallel with the Seine for some distance, and then turns to the south and flows into it at a point rather beyond and to the west of the city.

This brook, or "great drain," receives the drainage of the northern slope of the south bank. The southern slope, together with the south bank and the islands of St. Louis and Notre Dame, drain direct into the river.

In eighteen hundred and thirty-three a complete survey was made of the existing drains, and their respective levels ascertained, with a view to intercept as many as them as possible, and to carry the sewage beyond the city boundaries.

The house sewage, or fæcal matter, has no connection with the drains of Paris, except in one or two cases. Most of the houses in Paris are built in blocks, having a central court-yard common to all. In this is usually formed a cesspool, which receives all the night-soil, etc., and is emptied at intervals. This operation is carried out almost entirely without unpleasant smell. The exceptions, above alluded to, are where in some parts of the city and at barracks a new system is being carried out. It consists in conveying the night-soil by earthenware pipes from the houses into cylinders in connection with the branch drains. These cylinders are perforated with small holes, which allow the liquid to flow through into an outer casing, leaving the solid matter within. The internal or perforated cylinder is withdrawn at intervals and emptied. The night-soil from the cesspits and these interceptors is carted away. Much of it is sold and converted into manure, but large quantities are still wasted.

The duty which the new sewers have to perform is to carry off the rainwater and house-slops.

A large portion of the city was continually being flooded by the river, so that whilst carrying out the new drainage scheme the river was embanked above ordinary flood level, in consequence of which the sewers are enabled to drain the lower districts satisfactorily during heavy storms.

By the new scheme the city was divided into five drainage areas or districts:

1. The South Bank, the sewage of which is carried in one main sewer along the river bank. It then crosses the river by two iron syphon pipes, and discharges into the great main sewer on the northern bank.

2. The Isles of St. Louis and Notre Dame, the sewage of which is discharged through two outlets, under the banks, into the river.

3. The Right Bank, Southern Slope, the sewage of which discharges into the great main. This sewer is carried along the river bank to its junction with the northern syphon, and thence to its outlet at Asnières.

4 and 5. The Right Bank, Northern Slope, and Extra Mural—both of these areas discharge into the "great drain," which empties into the river at St. Denis.

Before these main sewers were constructed it was necessary to remodel the existing drains, and to drain a large portion of the town at that time without sewers. The only available means for getting rid of the rain water, etc., were by open channels down the center of the streets.

The Parisian sewage discharges, as will be seen above, into the Seine by two outfalls—one at Asnières and the other at St. Denis (excepting the islands, which discharge as described)—the former being of five times a greater capacity than the latter. The natural formation of the city has allowed the new sewers to be so constructed that they discharge, at the outfalls, into the Seine by gravitation alone, without any assistance by pumping.

The forms of the sewers adopted for the new drainage system are shown on Plan No. 8, Figures 1 to 8—the minimum inclination or fall being three feet three inches per mile.

As, however, it was not possible to give the main sewers a sufficient slope to enable them, under all circumstances, to carry off the heavy matters in suspension, it has become necessary to resort to hand labor and mechanical agency to get rid of the accumulated deposit.

In order to form sewers of such magnitude as the above, it was necessary to raise a great many streets, and otherwise alter them. The surfaces of the roads were altered from a concave to a convex cross section, having gutters at the side instead of in the center, as formerly. This entailed a heavy expenditure, and the carrying out of some very difficult work. For instance, in the Rue Lafitte, and at the foot of the Rue des Martyrs, a new drain was built to carry below the surface of the road all the rain water, which previously poured in torrents down the Rue du Faubourg Montmartre, lying immediately below it. The difficulties met with in the execution of this drain were very great. In the first place, it was necessary, for some distance, to sink it at a depth of about nineteen feet below the surface. This was done in open cutting, in the lower beds of which the soil was semi fluid; and in the second place there were most offensive exhalations from the foundation. This drain was carried below that in the Rue des Martyrs, and, at the point of crossing, a large cast-iron pipe was used.

Many other instances occurred of extremely difficult character.

A comparison between the old and new sewers shows a great difference in two respects: First—In the new sewer the area is many times greater, though that portion allotted to the sewage is about the same. Second—In the formation of footpaths and tramways at the side of the sewers. The most general form of sections used are shown in Figures 1 to 5, but where it is impossible to obtain the required height, the less important sewers are built as shown in Figures 6 and 8. It will be seen that the general section is composed below of an almost rectangular trough, the bottom being slightly curved, and the corners rounded. Above this, the width is greatly increased, so as to give a platform on each side of the trough. The trough forms the ordinary channel for the sewage, but in heavy storms the water runs above the level of the footway, and more or less fills the whole arch. In this case, the work-

men have to rapidly retreat for safety, and to facilitate this end, chambers have been built as often as possible, where the headway will allow, in the crowns, or roofs, of the drains. These chambers are reached by an opening in each side of the side walls, ladder irons being built into the masonry, projecting about six inches, and forming a means of ascent to the crown of the arch in the side opening, and communicating with a flight of steps leading to the chambers formed on the extrados of the sewer. On the south side of the river, the levels of the surface above the main drain do not admit of any such chambers being constructed, consequently a number of shafts, communicating directly with the street, have had to be formed, up which the workmen can escape.

In the arched upper portions of the sewers which form subways, brackets are built into the masonry to carry the water and gas mains, pneumatic tubes, and telegraph wires, thus preventing the constant disturbance of the street surface, so common elsewhere.

The principal sewer at Asnières collects the sewage of about thirty square miles, containing sixty-six thousand houses, and about one million eight hundred thousand inhabitants. On an average the stream has a width of eleven feet and six inches, and a depth of three feet and eight inches, flowing over about eight inches of mud, and a speed of three feet per second, discharging about eighty-nine cubic feet per second. At St. Denis the speed is one foot and eight inches a second, and the discharge about sixteen cubic feet per second—equal to about eight million one hundred thousand cubic feet per day—which is rather less than the water supply, though the observations include the average rainfall. The outfall varies according to the hour of the day, and it is easy to trace the variations in the cleansing of the streets and in domestic services. But besides these causes the outfall is affected by variations of rainfall. In December, eighteen hundred and sixty-eight, after continuous rains, the speed of the current at Asnières exceeded six feet and six inches, and the quantity two hundred and eighty-one cubic feet per second. In May, after an exceptional storm, the rate was thirty-two feet and six inches, and the quantity one thousand five hundred and eighty-four cubic feet per second, making a daily outfall of one hundred and thirty-seven millions of cubic feet. Sand is stored in heaps along most of the roads, to fill the puddles and maintain an even and dry surface. During a fall of rain this is worked into mud and carried, together with the road refuse, into the drains. The large section of the drains prevents the water, except in cases of storms, running to more than a couple of feet in depth in the generality of them, and often not more than a few inches in the Summer. In consequence of this, the flow in them is so sluggish as to allow of even the suspended matter in the sewage depositing, so that the sand, etc., from the roads, rapidly accumulates, and has to be removed by a large staff of men employed for this purpose. Some of the means used to remove the deposit are as follows: such drains as have not a pathway formed in them are cleansed by hand labor, the mud being removed through the air-shafts by seventy or eighty men and thirty carts. Those drains having pathways are all cleansed by mechanical contrivances, which differ in some details, according to the sizes of the sewers.

The larger sewers are cleansed by means of a large iron scraper attached to the bow of a shallow boat; this scraper nearly fits the section of the sewer, and can be raised or lowered from the boat by machinery. The modus operandi is to lower the scraper till it is a sufficient depth in the mud; it thus forms a dam behind which the

water accumulates until there is enough force to propel it, and the mud in front of it, forward. When so much mud has thus collected as to stop further progress of the boat and scraper, valves, formed in the sides and bottom of the scraper, are opened by the workmen in the boat. The pent-up water rushes through these openings, stirs up the mud in front of the scraper, keeping it in suspension (this is also assisted by men with scrapers), and in this way a further length of the sewer is cleaned. The mud is often of so great a depth as to prevent removal by one operation; in which case the scraper is only partially lowered into it, and the residue cleared by a second or third operation. In dry weather, it often occurs that there is not sufficient water to work this boat, in which case a length of the sewer is dammed by means of an iron frame, which is ordinarily suspended to the roof of the subway, being lowered by machinery into the water-way, which it exactly fits, and where it is kept in position by chains. In this way enough water is penned back to admit of the boats and scrapers being brought into operation. The boat is kept in proper position by a cross-head fixed horizontally at the stern, having iron rollers at its extremities. These can be adjusted so as to work up against the water-way, and prevent the possibility of the boat slewing. Each boat is attended by three men, and is fitted with seats and tool locker, etc. It has been found that under even the most favorable circumstances, not more than one thousand yards of sand can be cleared in this way per day.

The smaller drains are cleaned by means of a truck running on a rail fixed on each pathway so as to be over the water-way, and having a scraper, similar to that before mentioned, attached to it. This can be raised or lowered by a crab gearing on the truck, the cleaning being performed as before detailed. The rails are formed of angle irons.

When a sufficient quantity of mud has collected at one spot, it is lifted by workmen into tipping trucks running on the rails laid on the pathways, and they are then run out to the tipping station, discharging their contents into barges to be carried away. There are two tipping stations—one at the Place du Châtelot, for the sewers on the north bank of the river, and the other at the Quai St. Michel, for those on the south bank. The sewers are not usually cleaned until the mud has accumulated to a depth of four or five inches.

The velocity of the Seine is not sufficient to carry off the heavy matter emptied into it from the outfalls, and, consequently, mud deposits in the river bed, and has to be cleared away by dredging, at a cost of three thousand two hundred pounds per annum.

There are seven large store chambers constructed at different parts of the city, in which the boats, wagons, scrapers, tools, etc., are kept. These chambers are approached by a flight of steps, leading from the pavements above, the entrances to which are closed by large iron doors. One of these chambers measures not less than one hundred feet by forty-five feet, by fifteen feet high, and is covered by a segmental arch. Rails, sidings, turntables, and all other conveniences for carrying on the work of cleansing and repairing, are amply provided.

Notwithstanding the necessity for breaking up and agitating the mud, there is no offensive effluvia whatever arising from the sewage water.

Storm overflow weirs are provided at several points along the courses of the main sewers.

The materials of which the sewers are built vary considerably. The main sewers are constructed of coursed rubble sandstone, the joints

being pointed with cement. The old branch drains are built of stone, random rubble, with ashlar inverts, the whole of the inside being plastered. The new branch drains are formed of either of two materials. One consists of coarse sandstone, in small unbedded pieces, laid in a kind of mortar made of unsifted sand and gravel and hydraulic lime. It is laid in a dry, stiff state, very little water being used. This mortar comprises about sixty per cent of the whole of the material of which the drain is formed. The other consists of *béton*, or concrete, formed of clean river sand and ballast and Roman cement, in the proportions of five to one. The interior of all these drains is plastered with hydraulic lime, or Roman cement and sand. The foundations of most of the sewers are formed of concrete.

The total length of sewers in Paris is about two hundred and fifty miles.

Subjoined is a comparison between some of the principal features of the drainage of London and Paris:

LONDON.	PARIS.
The drains receive every kind of sewage.	The drains receive only rainfall, household water, drainage from public urinals, and the liquid portion of the drainage of a few houses, etc.
Night soil is carried off by the sewers.	Night soil is collected in cesspits and removed by hand labor.
Road washings are carefully excluded from the drains.	Road washings are received into the drains.
The sewers are used for sewage alone.	In addition to the sewage the sewers receive gas and water mains, etc.
The drainage is effected by gravitation and pumping.	The drainage is effected entirely by gravitation.
There is a tide to contend against.	There is no tide, but a stream to carry away suspended matter.
The principal outfalls are fourteen and fifteen miles from town.	The principal outfalls are one mile and one and a half miles from town.
The river is tidal, and therefore any sewage discharged into it near the town is brought back by the returning tide.	The river is not tidal, which prevents the return of sewage matter discharged into it.
Great economy exists in having small drains.	Large drains are necessarily expensive.
The egg-shape sewer, and the circular, where there is a constant and large flow, give the greatest hydraulic mean depth, and consequently the strongest current.	The wide flat section for the waterway gives a minimum depth, and weak flow consequently.
With an inclination of one in two thousand six hundred and forty, or two feet per mile, there is little or no deposit.	With an inclination of three feet three inches per mile, and even one in one thousand, there is much deposit.

LONDON.	PARIS.
Nine-inch pipes are used.	The smallest sewer built is five feet six inches by two feet six inches.
The highest mean temperatnre in Summer is sixty-two degrees, and the mean temperature fifty-five degrees.	The mean temperature throughout the year is sixty-three degrees.
The sewage contains seven parts of oxygen per one hundred thousand, and holds sixty-nine and one half in suspension, of which sixty-one per cent are mineral.	The sewage contains four parts of oxygen per one hundred thousand, and holds one hundred and ninety six parts in suspension, of which seventy-five per cent are mineral.
The cost of flushing the sewers and emptying the catchpits, etc., is forty pounds sterling per mile.	The cost of cleansing is one hundred and twenty pounds sterling per mile, exclusive of the cost of the emptying and removal of the contents of the cesspools.

E. B. S. KNOX, Assos. Inst'n C. E.,
Late Engineers' Department Met. B'd W'ks, London.

POISONING BY GUM BOOTS, ARSENICAL FABRICATIONS, ETC.

By T. M. LOGAN, M. D., Secretary State Board of Health.

Early in the present Summer the attention of this Board was called to an article in the Oroville *Mercury*, Butte County, stating that "the gum boots, so universally worn by gravel miners, have latterly been lined with green flannel, the dye of which is unquestionably arsenicated, and which has poisoned many persons, some fatally." Knowing how common the use of arsenic in arts and manufactures has become, and therefore apprehending that there might be some truth in this statement, I wrote to several physicians, practicing in the mines, and requested them to investigate the matter. Dr. Miller, of Oroville, promptly responded to the request, and satisfied me that there was little or no foundation for the statement. The matter, thus disposed of, soon passed from my mind, and the correspondence was so carefully hid away for future reference, that it cannot now be laid hands upon. Recently the question has again been opened by *The Mining and Scientific Press*, and other papers; and, as will be seen, in the appended communication, Dr. Miller has again responded to a second application on my part.

Although Dr. Miller, after proper investigation, has come to the conclusion that the injury inflicted by the use of gum boots, in the cases examined by him, was not attributable to the arsenical green dye of the lining, still there is no good reason why such a contingency may not occur; and for this, as well as other considerations, it is deemed that the subject is one which warrants solicitude in behalf of the public health, and exacts something more than a passing notice.

Arsenic forms an ingredient of two pigments in constant use, the arsenite of copper, Scheele's green, and the aceto-arsenite of copper, Schweinfurt green. Either of these combinations have, on account of their comparative cheapness and brilliant color, always maintained favor both with manufacturers and the public in general. So important has their application been considered in the application of wall paper, of artificial flowers, and other articles of decoration and dress in Paris, that when at one time it was agitated, whether it were practicable to prohibit the use of arsenic in these arts, certain manufacturers protested that such an edict would necessitate the absolute suspension of their works.

In eighteen hundred and sixty, a manufacturer of paper hangings in England stated that he used two tons of arsenic weekly, (1) and the amount of the color annually manufactured in that country was

(1) Taylor on Poisons.

estimated in eighteen hundred and sixty-two, at from five to seven hundred tons (1). In fact, so general has become the employment of arsenic throughout the world, that "we doubt very much whether it would not be impossible, at the present day, in any country, to convict on chemical evidence before any jury, the most bungling arsenical poisoner, if he or she had a legal defender who would make such use as he might of the argument furnished him by the almost universal distribution of the venomous elements throughout our most familiar walks of life. We have received medicines, ourselves, from the drug stores, wrapped in arsenical papers put up in Paris-green paper boxes, with arsenical paper caps tied over the corks, etc. We have often seen confectionary exposed for sale to young children wrapped in the deadly green paper. We have often found young children sucking toys painted with the horrible stuff, and with their mouths stained throughout with the venom. The Paris-green paper is one of the commonest in use for binding school books, and we have more than once taken such books away from our own young children, which had been given them by their teachers. Numerous deaths of children are well known to have been thus occasioned. No country can be called civilized in which such suicidal ignorance, such stupid slaughter of the innocent, is common. One more illustration only. It is very common to see a lawyer or his clerk, put into his mouth, to moisten the gummed sides of it, a beautiful green paper disk, with scolloped edges, to attach to some document. These things are found in every lawyer's office in the land, and used constantly. They are seldom made of any other than the Paris-green paper. * * * These things, we say are facts, on both sides of the Atlantic; but, really, while we wrote the first part of this article—especially when we thought of the recklessness of the public press, which has actually recommended their rural readers, in many cases, to pile on the Paris-green on their potato patches with a perfect looseness—these other things seem trifles as flat and stale as they certainly are unprofitable; and our enthusiasm and zeal for the cause of humanity seems to wilt down into a sort of sentimentality, which is certainly ludicrously lame and impotent, if not downright sickly." (2)

It must not, however, be inferred from what has just been stated, that all green pigments in ordinary use are arsenical. Not a small proportion of the green colors employed for dyeing or color printing, and other artistic work, are of comparatively harmless composition. As it is not always easy to distinguish them by their physical appearance, we here give the ready test which chemistry affords, and which may be easily applied. The suspected green material is to be placed in a solution of ammonia (aqua ammoniæ). If arsenite of copper be the coloring agent, the liquid will acquire a blue tint, from the disengagement of the oxide of copper from its combination with the arsenic. If a further test be desired, a few drops of the colored ammonial solution poured upon crystals of nitrate of silver, will leave on the crystals a deposit of yellow arsenite of silver.

Having said this much by way of affording a ready means for the detection of this universal poison, as well as for the purpose of warning the public of the dangers pertaining to its indiscriminate employ-

(1) Fifth Rep. of Med. Officer of Privy Council, 1863; as quoted, in 3d Annual Rept. of St. Bd. of Health of Mass.

(2) Prof. Henry Wiertz, *American Gas Light Journal.*

ment, I now leave the following communication to speak for the case in point:

Doctor T. M. Logan, *Secretary of the State Board of Health:*

My Dear Doctor: I regret exceedingly the loss of my communications with you relative to the reputed cases of poisoning by gum boots alleged to have occurred in Stringtown, Butte County, and reported in two issues of the Oroville *Mercury*.

Protracted illness in my family has almost rendered me, for the present, unfit for any thing like mental exercise, but as a report of the matter is considered by you interesting and necessary for the furtherance of the public welfare, I will endeavor to give it my best attention and consideration, and, although brief, perhaps, sufficiently explicit to convey my impressions of a subject which I characterize as the emanations of a fertile but prejudiced mind.

Sore legs, as they have been termed, occurring from the continued use of gum boots, were and are no rare phenomena in this part of the country, even dating from eighteen hundred and forty-nine, down to the present day. On the contrary, the absence of such conditions were very rare until it was discovered that daily ablution and other cleanly measures exercised a prominent part in the prevention of these superficial morbid conditions, which, when neglected, became a source of much constitutional trouble. There are, however, many left, whose habits cannot be changed, and no adequate amount of reasoning can adapt them to the same channel of thought as is followed by those who consider the daily employment of gum boots (if this important matter be neglected), receptacles of pent-up animal matter, and perspiratory exhalations: conditions which finally produce varices, chronic inflammation, œdema, together with indolent ulcers of the parts subjected to undue heat by the close fabric and water-tight material of which gum boots are made. The most casual observers of the effects of gum boots are acquainted with the fact that no bad results follow their use so long as cleanliness is strictly observed; but when the opposite plan is indulged in, the usual phenomenon of the want of ablution and ventilation is quickly manifested in the conditions already related.

It is needless to mention that the reports of this affair which appeared in the *Mercury*, are based upon one single case of inflammation of the legs, brought about by causes already alluded to; and so far as the assertion goes that there are large numbers suffering from the symptoms of poisoning, I can only regard it as a false and most unwarrantable report. I promptly examined the man, the subject of his report in the *Mercury*, and found him—just as I expected—merely complaining of chronic inflammation of his legs. He distinctly refused me a proper and thorough examination of his case unless I promised, under any circumstances, to give evidence in favor of the theory of the poisonous effect of gum boots, should an action for damages be instituted against the boot companies. This I denied him most emphatically unless I could discover poison in the green lining. The other cases of which the same writer to the *Mercury* made mention, I will briefly notice, since I am thoroughly acquainted with them. They are the subjects of chronic rheumatism, arising as a sequel of remittent fever, of syphilitic nodes, lepra vulgaris, and psoriasis. Varices occasioned by inflammation, the result of heat originating from the constant use of gum

boots, is generally the condition denominated as poisoning by the writer in the *Mercury*. Indeed, while writing this report, I was consulted by an intelligent miner (John Gramps, of North Fork, Feather River), regarding a swelling of his legs, from whom I solicited the following remarks:

"I enjoyed excellent health till within the past two years, when I observed a swelling of my legs. There has been considerable pain together with unbearable itching ever since. Never paid proper attention to my feet and legs. Did not consider it necessary. Have been wearing gum boots of Hawyard's and National Rubber Company's brands for the past sixteen years. Always suffered more or less from itching consequent on their use. Attribute the irritation and tingling of my legs to heat and excessive perspiration induced by the wearing of all kinds of rubber boots. Have never suffered from general irritation of the skin, nor suffusion of the eyes. Have not suffered from inflammation of the conjunctive. Have not complained of intolerance of light, nor a falling off of the hair. Was at no time partially paralyzed."

Having thus obtained the information I desired, I proceeded to examine the condition of his legs, and found an excellent example of varix of the internal saphenous vein, together with considerable inflammation, and a strong tendency to ulceration. You will observe that no symptoms of chronic poisoning by arsenic are observable in the history of the above case, and much less have such symptoms been perceived in those who suffer from chronic diseases and enumerated as poisoning by gum boots by our local writers. I have tested the fabric with which the Hawyard's and the National Rubber Company's boots are lined, and find no trace of arsenic or any other poisonous coloring matter. The green linings which I subjected to a chemical analysis for arsenic were taken from boots cast away as unfit for further use, bearing the brands of Hawyard, Colchester, Conn., and that of the National Rubber Company, R. I. For that reason it is barely possible the poison may have been disengaged from the flannel (if it contained any) whilst in use. The result of my investigations, however, does not bear out such a supposition, for I think that Hawyard's latest patent in which a grey felt textile is employed instead of green lining as heretofore, is as productive of the bad results generally attributed to gum boots as that manufactured by the National Rubber Company, who employ no other lining but the green which has been so long in use. I have received much important information on this matter, from gentlemen of experience. Among them Mr. West, of Oroville, a gentleman of intelligence and integrity, and find the bulk of reliable evidence in favor of the opinion which I have already expressed. Trusting that my endeavors at a solution of this question may be satisfactory,

I am, dear sir,

Fraternally yours,

P. B. M. MILLER, M. D.

Oroville, August 25th, 1875.

REPORT

OF THE COMMITTEE OF THE "CALIFORNIA STATE MEDICAL SOCIETY" ON STATE MEDICINE AND PUBLIC HYGIENE, CONTAINING A DRAFT OF "AN ACT TO PROTECT THE SANITARY INTERESTS OF THE PEOPLE AGAINST FRAUD AND IMPOSTURE IN THE PRACTICE OF MEDICINE," APPROVED APRIL TWENTY-SECOND, EIGHTEEN HUNDRED AND SEVENTY-FIVE.

By THOMAS M. LOGAN, M. D., Chairman of the Committee.

Mr. President and Gentlemen: In my report, as Chairman of the Committe on "State Medicine and Public Hygiene," I called the attention of the society, at the last meeting, to the necessity of making some provision for the regulation of the practice of medicine in this State. I took the position then which I held before the passage of the Pharmacy Act of March twenty-eighth, eighteen hundred and seventy-two, and which I still maintain, that it is as much our duty to protect the public against the evils of dosing patent medicines, and, perhaps, the greater evil of swallowing the improperly compounded prescriptions of competent and incompetent doctors, as it is to point out and provide against the noxious influences of foul air, or the poisonous gases of filthy sewers.

If this committee was appointed to propose measures for the consideration of the State Board of Health, looking to the enactment of sanatory laws to protect the people from whatever may be found detrimental to human life, is it not also incumbent on them to insist upon further legislation to prevent the destruction of that same life by the illicit exercise of a calling under false pretenses?

Influenced by such considerations, I asked, with a view of devising some means for the practical solution of this question, that a committee of three or more might be appointed by this society, to confer with the Professors of the schools of medicine in preparing a bill for presentation to the Legislature, and to be submitted for approval at this meeting. It was at the time suggested, that in this bill there should be nominated a State Board of Medical Examiners, to consist of eleven members, viz: the President of the State University (to have only a casting vote), the President of the State Medical Society, the Professor of Physiology in the State Normal School, the Professor of Chemistry in the State University, the Secretary of the State Board of Health, two Professors from each of the medical schools, one Professor from the College of Pharmacy, and the Superintendent of Public Instruction.

The provisions of the bill were to embody the substance of the resolution of Dr. Oatman, concerning the doctorate, lying over from a previous meeting, and to constitute the above named eleven members, in accordance with the resolution of Dr. Morse, an independent State Board of Medical Examiners, with power to confer the medical diploma

of the State upon all candidates, irrespective of the source of instruction in which the applicant had been educated; *provided*, he passed a satisfactory examination in descriptive and pathological anatomy; physiology and histology; principles and practice of surgery; organic and inorganic chemistry; principles and practice of medicine; private and public hygiene; obstetrics and diseases of women; materia medica and therapeutics; and the various branches of elementary scientific knowledge.

The resolution of Dr. Oatman referred to is this:

Resolved, That it is the duty of, and we hereby recommend to, the Legislature of California, to pass a law making it a misdemeanor for any person, for any purpose whatever, who is not a graduate of some institution of learning authorized by law to confer the degree of "Doctor of Medicine," who shall place before or after his or her name, in any manuscript, label, wrapper, card, handbill, circular, newspaper, pamphlet, magazine, book, or any advertisement, the word "Doctor," or the abbreviation "M. D." or "Dr.," or any others signifying, directly or constructively, that person is a graduate of such an institution, or who shall authorize or sanction the same by others in his or her interest; and that any person found guilty of such a misdemeanor shall be punished by a fine of not less than —— dollars, or imprisonment for not less than —— years, or by both such fine and imprisonment.

Dr. Morse's resolution reads thus:

Resolved, That the State Medical Society of California, desiring to see some system adopted by which a high and liberal standard of medical education and graduation may be secured, have heard with great pleasure that our State University contemplates the organization of an independent Board of Medical Examiners, and we do hereby express the hope that such a Board may be appointed, on a foundation so independent, that, upon their certificate of graduation, a diploma of the University will be granted and conferred, irrespective of the school or source of instruction in which the applicant has been educated.

The discussion of the question hinged on the adoption of Dr. Morse's resolution, when the following resolutions, offered by Dr. Henry Gibbons, and accepted as an amendment, were unanimously adopted:

Resolved, That it is desirable that there should be a uniform system of examination for the degree of Doctor of Medicine, apart from the institutions for teaching, so that the diploma shall be awarded to all competent candidates, and the profession, and society at large, shall be secured against the possibility of the degree of Doctor of Medicine being conferred upon unworthy or incompetent individuals.

Resolved, That a committee of five be appointed by the Chair, to prepare and present, at the next meeting of the society, some plan by which the said object may be accomplished.

Accordingly the President named a committee consisting of Drs. Morse, Shurtleff, Logan, Gibbons, and Hewston. Here the question rests; and here, perhaps, it will remain forever.

Were he, whose eloquent tongue so boldly advocated the plan proposed—in fact, who originated it, now present, there might be no misgiv-

ings as to its final disposition. Gifted as he was with the rare art of transferring his impulses to others, it is highly probable that he would have borne down all opposition. But the echoes of the glowing words, with which he proclaimed his broad, catholic views, soaring above the senseless *'isms* and *'pathies* of the day, and disclaiming exclusive recognition of any school or college, though still ringing in our ears, will never more be renewed. That voice, which in manly tones, invited all honorable and self-respecting representatives of all sorts of medical practice, irrespective of any denomination, to demand of the law-making power, that it provide some guarantee that the people may not become victims to the ignorant doctor, is hushed in silence forever more. But although Dr. Morse is not here to act his part as Chairman of the committee referred to, and although, perhaps, the ability of any single member of this society would prove ineffectual in bringing about a union of the divergent views as to the method of action and peculiar course he advocated; still I think that if all of us would act as a unit in the great object we have at heart, viz: the protection of the lives of the community, by indorsing some such statute, as soon to be proposed, we would accomplish all that is required.

Looking attentively at the social progress of our day, none of us can fail to observe that the feeling of antagonism, which has hitherto existed between the public and the profession, is rapidly dying out. In fact, no stronger exemplification of Spencer's "working out of sociological processes"—of the marvellous results "indirectly and unintentionally achieved by the coöperation of men, who are severally pursuing their private ends," can be produced, than that of the present relative position of medicine and the public.

Ever since the advent of that equalizing spirit, which, enlightened by a knowledge of political philosophy, set up our popular form of government, but which, at the same time, working in the shadow of an ignorance of medical philosophy, tore down the barriers which protected the practice of our art, have the efforts of the true followers of legitimate medicine been steadily directed towards educating the public mind to a just conception of the real situation.

So long as the people were made to believe, by the cunningly devised sobriquet of allopathist, that the followers of the comprehensive science of medicine were merely the disciples of one of the *pathies*—that if there was a distinction, there was no difference between the homeopathist, and (if I may be allowed to coin a new term), the omnipathist, so long were we helpless and powerless. But thanks to the spirit of forbearance manifested by the members of the profession, while pursuing the even tenor of their ways, and spreading abroad correct, intelligent ideas in regard to medicine, all classes of society have come to understand the principles of our science to a degree sufficient to respect and confide in us; thus insuring to the physician, of the present and succeeding times, a high position, not only in the hierarchy of the sciences, but also in the social scale.

No better evidence of the truth of this assertion is requisite than the fact, which is patent and cognizant to all, not only in California, but throughout the length and breadth of the United States, that the very persons, editors of newspapers, ministers of the gospel, members of our Legislatures, and Judges—law-makers as well as law-expounders, and law-executors—who were once most officious in disseminating the fallacious notions, just alluded to, are now the most clamorous for the enactment of prohibitory laws, to check the present wholesale poisoning by

drugs and medicines. In California, especially, has this reactionary influence been made most plainly perceptible. Owing to the peculiar circumstances under which the State was suddenly settled up by a heterogenous admixture of all nationalities, there were no means of ascertaining the qualifications of the great army of doctors which rushed in. Health and every other consideration gave place to the one idea of getting rich quickly; and when overtaken by sickness, too often caused by the reckless habits of the earlier settlers, the patient called in the physician nearest at hand. Quackery thus became rampant, and diplomas were not of as much value as pocket-knives.

But if California has, for these reasons, suffered more in proportion than the other States from the abuses of medicine, she has taken precedence, in point of age and time, in applying an effectual corrective. The people themselves have taken the matter in their own hands, and through the columns of the newspapers are sifting the competent from the incompetent doctors. And more than this, I have been called upon, as the Chief Sanatory Officer of the State, to prepare a bill for presentation to the next Legislature, looking to the prevention of the practice of medicine and surgery by unqualified persons. I see no good reason why statutory measures, which are now being enacted in other States, should not be resorted to in California, inasmuch as there appears to be no other help, except an appointment of physicians by administrative authority—a plan current in Europe, but offensive to the theories of our government. Without occupying your time, therefore, with the further discussion of the urgent necessity for purging the community of ignorant pretenders, I herewith present, for your consideration, the following, almost *fac simile* of an Act which has recently become a law in our sister State of Nevada, and to which I have annexed (section four) the substance of a proposed amendment, by the Central New York Medical Society, to an Act passed May eleventh, eighteen hundred and seventy-four. I would add that it is also contemplated to have an amendment made to the Act regulating the practice of pharmacy in the City and County of San Francisco, approved March twenty-eighth, eighteen hundred and seventy-two, so that the law may apply to every city and town, wherever there is a drug store, or wherever physicians' prescriptions are compounded.

AN ACT

FOR THE BETTER PROTECTION OF THE SANITARY INTERESTS OF THE PEOPLE AGAINST FRAUD AND IMPOSTURE IN THE PRACTICE OF MEDICINE AND SURGERY.

(*As revised and approved by the Committee.*)

The People of the State of California, represented in Senate and Assembly, do enact as follows:

SECTION 1. No person shall practice medicine and surgery in this State, who has not received a medical education and a diploma, from some regularly chartered medical school, having a *bona fide* existence at the time of giving said diploma; or who shall not have obtained a license to practice medicine and surgery from a State Medical Society or a State Board of Medical Examiners, duly authorized by law to grant such license when the same was given; or who shall not have received a *certificate of qualification*, to practice medicine and surgery from the State Board of Health of this State, as provided in section four of this Act.

SEC. 2. Every physician or surgeon, when about to take up his residence in this State, or who now resides here, shall file for record with the County Recorder of the county in which he is about to practice his profession, or where he now practices it, a copy of his diploma or license (at the same time exhibiting the original), or a certificate from the Dean of the Medical School of which he is a graduate, certifying to his graduation.

SEC. 3. Every physician and surgeon, when filing a copy of his diploma or license, as required by section two of this Act, shall be identified as the person named in the papers about to be filed, either by the affidavit of two citizens of the county, or by his affidavit, taken before a Notary Public or a Commissioner of Deeds for this State, which affidavits shall be filed in the office of the County Recorder.

SEC. 4. Every person who shall hereafter practice medicine or surgery in this State, unless such person be authorized to practice by a license or diploma from some chartered school, State Medical Society, or State Board of Medical Examiners, shall obtain, and is hereby required and directed to obtain a certificate from the State Board of Health, which Board is hereby authorized and empowered to issue a certificate to the effect that they have examined and do find the persons named in such certificate, and to whom the same shall be issued, qualified to practice all the branches of the medical art, if such be the fact; and the person to whom such certificate, license, or diploma, may be granted, shall, before he shall practice medicine or surgery in this State, cause such certificate, license, or diploma, to be recorded in the office of the Clerk of each county in which such person shall from time to time reside. And the Clerks of the several counties of this State shall procure and keep suitable books, in which they shall record such certificates, tested as aforesaid, and such license or diploma, whenever pre-

sented to be recorded, upon the payment to them of the same fees as required to be paid for recording conveyances of real estate; and shall index, in alphabetical order, the name of the person to whom such certificate, license, or diploma, shall be granted—noting therein, opposite to the name indexed, the book and page where such certificate, license, or diploma, is recorded, the date of the instrument, and of the recording of the same.

Sec. 5. Any person practicing medicine or surgery in this State without complying with sections one, two, three, and four of this Act, shall be guilty of a misdemeanor, and, upon conviction, shall be punished by a fine of not less than fifty dollars ($50), nor more than five hundred dollars ($500), or by imprisonment in the county jail for a period of not less than thirty (30) days, nor more than three hundred and sixty-five (365) days, or by both fine and imprisonment for each and every offense; and any person filing, or attempting to file, as his own, the diploma or certificate of graduation of another, or a forged affidavit of identification, shall be guilty of a felony, and upon conviction, shall be subject to such fine and imprisonment as is made and provided by the statutes of this State for said offense.

Sec. 6. It shall be the duty of the Police, Sheriff, or any Constable, to arrest all persons practicing medicine or surgery in this State who have not complied with the provisions of this Act, and the officer making the arrest shall be entitled to half of the fine collected.

Sec. 7. No portion of this Act shall be so construed as to prevent gratuitous efforts to afford medical or surgical aid and relief in cases of emergency or accident; or to prohibit parents or persons acting *in loco parentum*, from administering medicine or remedies to members of their own families.

Sec. 8. This Act shall take effect and be in force from and after its passage and approval.

REMARKS ON THE CLIMATE OF SAN FRANCISCO AND OF CALIFORNIA,

WITH SPECIAL RELATION TO PULMONARY DISORDERS.

By HENRY GIBBONS, M. D.

Much has been written concerning the climate, or rather the climates, of California, with special reference to health; and yet but little is positively known in regard to the best localities for consumptives and other invalids. There are intrinsic difficulties in the way of reaching definite conclusions on the subject. Impressions made by a brief sojourn in a place, vary with the individual; the same climate being agreeable to some and unpleasant to others. Meteorological statistics give no adequate idea. The temperature may be equable, but if its range be about the lowest point consistent with comfort, the slighest depression will destroy the benefits of its equability. Air in motion is very different as to comfort and health from air at rest, though the temperature be the same. Moisture is another important element, the precise relation of which to health cannot be represented by figures. Still less tangible is electricity, though potent.

As to the mortuary statistics of pulmonary disease, they are extremely uncertain. A locality unfavorable in this respect may make a good showing, by reason of its abandonment by those who seek relief elsewhere; while on the other hand, the most favorable locality may be made to appear the most fatal, by becoming a place of resort for consumptives from other parts.

There are four elements of climate which are of intrinsic value in a hygienic point of view: first, temperature; second, wind; third, moisture; fourth, electricity. Let us examine these briefly, in detail:

1.—TEMPERATURE.

Judging from temperature alone, the ocean climate of California ought to be most salubrious. Its character is due to an ocean current from the north, the reflex of the gulf stream of the Asiatic Coast. By this polar current the western shore of the Pacific States is continually bathed with a temperature of 52°, with scarcely the slightest variation from Winter to Summer. The ocean imparts its own temperature to the superjacent air, which flows in upon the land in a great and constant wave almost every day for eight or nine months of the year. For the most part this wave is soon arrested by mountain walls. But there are breaks here and there, one notably at the Golden Gate, through which it penetrates, distributing often to a great distance in the interior its coolness and moisture. Thus, immediately facing the ocean, we have the pure ocean climate; and this shades off gradually so as to present

a wonderful variety of climates in close proximity to each other. At least one half the occupied surface of the State enjoys the modified ocean climate.

The ocean climate has no considerable extremes of heat or cold. At San Francisco the lowest temperature for twenty-five years has been 25°, and this is a very rare degree of cold. In the majority of Winters the mercury does not fall below the freezing point. On a few days during the same period it has risen above 90°; and once it reached 98° and 99° on two successive days. These extremes of heat are generally in September, when the sea-breeze is abating.

An idea of the temperature of the climate of San Francisco may be gathered from the fact, that whilst some families have no fire in their houses, Winter or Summer, except for cooking, there are others who pass scarcely a day in the whole year without it. The same clothing is worn in Winter as in Summer. No one thinks of throwing off flannel in July or August. The nights are never warm enough to sit out-of-doors, or to sleep without blankets.

2.—WIND.

More important in regard to health than any other element of the ocean climate is the sea-breeze. It commences in the latter part of February, at first gentle and inconstant, and gradually acquiring force and constancy. The regular sea-breeze of Summer is almost from due west, never north of west, at San Francisco; but in the Spring months there is a tendency northward, and severe northwesterly gales are not uncommon. About the beginning of June the Summer regime is fully established, and the sea-breeze becomes a daily visitor. The mornings, however, are almost invariably calm until ten or eleven o'clock, when the great wave of ocean air comes in. At first it is not unpleasant, but by one or two o'clock it is tempestuous and chilling. From two to five o'clock P. M. it maintains its maximum force. It abates considerably about sunset, and by midnight subsides into a calm. The temperature of the sea-breeze is from 60° to 65° by day, with a minimum of 50° at night; and these figures represent the range of temperature on an ordinary Summer day.

The sea breeze reaches its maximum force in June and July, and is less violent in August. It continues to subside through September and October, and ceases in the beginning of November. After this date the air is calm, except when disturbed for a day or two by a rain storm from the southeast to southwest, or by an occasional dry norther. During the months of November, December, and January, most of the weather is perfectly calm, with a clear sky and a delightful atmosphere; vegetation advances slowly, and the country puts on the garb of Spring.

The sea-breeze, in those sections where it has full play, is the dread of invalids, and the abomination of most residents. After all, however, it has eminent virtues. It invigorates the laborer and infuses strength in every person of active habits; it stimulates the drone and quickens the sluggard; it sweeps away pestilential exhalations and preserves the purity of the atmosphere. Even the invalid may utilize it by a well devised and systematic course of hygiene. Outdoor exercise may always be enjoyed in the calm mornings, whilst in the afternoon it is proper to seek protection in the house. By observing these and other prudential measures which suggest themselves to all sensible persons, the unfavorable influence of the ocean climate may be warded off in a great degree,

and the coolness and purity of the atmosphere made to compensate for every disadvantage.

3.—MOISTURE.

A mistaken idea prevails in regard to the dampness of the climate of San Francisco and the surrounding country. As a general rule there is no mist with the sea-breeze before the middle of June, or later; then it comes in towards evening on a large proportion of the days during three months. But a drying tendency is, nevertheless, observed, and as soon as the supply from the ocean ceases by the subsidence of the wind, the atmosphere drinks up the visible moisture in its lower stratum. Whilst the wind ceases on the earth's surface it continues above, and the mist is carried over in the form of a low cloud. This cloud has an untold value to the interests of California. It flows in during the night, and until the sun dissipates it by its drying influence in the morning, and deposits its moisture on all the highlands and mountains presenting to the west throughout the Pacific slope. To this the redwood tree owes its existence. Without it, the immense forests so essential to the interests of the State would perish. So great is the quantity of moisture supplied by the passing cloud to the intercepting tree, that one may see the water running in streamlets down the towering trunk and forming puddles at its root, and maintaining an annual vegetation where no rain falls, properly speaking, for five or six months of the year.

During the months of December, January, and February, the atmosphere all over California is moist, almost to saturation, except where the north wind prevails. Dense land fogs are occasional. A dead calm exists for most of this period. Hence there is very little evaporation from the soil. But though the air is damp hygrometrically, it does not give the impression of moisture to the sensations. The sky is oftener cloudless for days and weeks together; and the bright sun, genial temperature, and still atmosphere, which prevail in the intervals of the rain, render the Winter climate of California delightful and charming. Strangers coming with their minds occupied by the idea of the "rainy season," are most agreeably disappointed. Only about half the seasons supply rain enough for profitable agriculture. The number of days on which rain falls averages less than sixty in the whole year. In the driest seasons the amount of rain, from one Summer to the next, is but seven or eight inches in the middle section of the State, and much less in the south.

Except on the borders of the ocean, and on the mountain sides where it deposits moisture in a visible form, the sea-breeze has a drying effect. It desiccates the soil with rapidity. Its evaporating power on water in ponds, or in vessels exposed to its action, is really surprising. The arts of domestic life are not disturbed by its moisture. The clothing on the line is dried in an hour—the salt in the cellar never deliquesces—the walls never "sweat." And this is true of all seasons of the year. A napkin wrung out of water and hung in the chamber in the evening, will be found dry in the morning, almost invariably, at all seasons.

On a large scale the drying power of the atmosphere of California is illustrated by the tendency to the absorption of cloud. During the Winter and Spring months, clouds are not wanting, even in a dry season. The upper currents from south and west bring in an ample supply, and the promise of rain is frequent. But farmers whose living depends on the rain, witness with chagrin the clouds absorbed by the thirsty

air, or rolling on over their arid fields, to deposit the moisture, if at all, on the distant mountains. The story of Tantalus is largely realized in California.

Another feature of our climate is the "norther," designated in the southern part of the State as *sand-storms*. These northerly gales occur in the Winter and Spring months, and commonly last three days. They belong to the interior, and are not much felt near the ocean. Sometimes they do mischief by their violence, but their chief evil is the injury to the crops. In the south they are most frequent and severe. Three or four "northers" may occur during the year. Occasionally they sweep the Bay of San Francisco with such force as to damage the shipping. They come on rather suddenly, commencing in the night or forenoon. The air is warm at first, but colder toward the close.

The north winds have a marked relation to the public health, particularly in the Valley of the Sacramento, and in localities farthest removed from the ocean. Invalids suffer from them, and complaint is made of the disturbance and discomfort which they inflict on the population generally. (1) They appear to owe their injurious influence on human health to their extreme aridity, aided possibly by some occult electrical agency.

4.—ELECTRICITY.

The relations of atmospheric electricity to health cannot be estimated. A remarkable absence of sensible electricity exists on this coast. There are at times changes of temperature and rapid formation of clouds, such as might be expected greatly to disturb the electrical equilibrium, but with rare exceptions lightning or thunder is not produced. Three or four times in the year, perhaps, those phenomena occur, mostly in connection with hail. Occasionally, though very seldom, the exhibition approaches the beauty and grandeur of an Atlantic thunderstorm. Nor is it common to witness electrical phenomena artificially excited, for instance, by the friction of clothing. On the whole, there is on this coast an absence of sensible electricity truly remarkable.

GENERAL REMARKS.

From what I have written, the reader will perceive that I regard the *wind* as the most important element of the ocean climate of California. The diurnal range of temperature is never great, but it occurs at that portion of the thermometrical scale which enables the wind to give it painful force. For instance, the morning is calm, with a temperature of 50° to 55° at sunrise; before noon the ordinary maximum of 60° to 67° occurs. With sunshine and calm air, this is just the point of comfort. Now comes the sea-breeze, depressing the mercury to 55° in an hour or two. This depression of six or eight degrees is trifling in itself, but is made chilling in the extreme by the high wind. Temperature alone considered, no more agreeable climate for out-door life could be found in the world than that of San Francisco. So far as it is unfriendly to consumptives or other invalids, the wind alone is at fault. It is never too warm for moderate exercise; and but for the wind, never so cold as to cause chilliness.

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(1) An excellent paper on this subject, detailing the noxious influence of the north wind, from the pen of Dr. H. W. Harkness, of Sacramento, was published in the *Pacific Medical and Surgical Journal* for May, 1869.

It is the prevailing belief that the climate of San Francisco is unfavorable to bronchial and pulmonary complaints. Until recently I entertained this opinion; but twenty-five years of observation and experience has modified it considerably. Persons coming to California from the East in quest of a climate which shall arrest the incipient symptoms of consumption, stop in the metropolis until their choice of a permanent sanitarium is made; but they often improve so rapidly as to render it advisable for them to remain, at least till the improvement ceases. I have known quite a number of individuals under these circumstances to regain their health completely. A gentleman within my knowledge, who was subject to occasional attacks of hemoptysis, would always fly from the interior to the city on the first indication of hemorrhage, always finding relief and safety in the tonic climate of the seaboard.

I may be pardoned for referring to my hospital experience on this subject, covering nearly fifteen years—a part of the time in St. Mary's, and the rest in the hospital of the city and county. Consumptive patients are brought to those institutions in all stages of disease, except the initiative, and from all parts of the State. Three fourths of them undergo a marked improvement for a time; and whilst a considerable number have the disease arrested and return to their friends after six months or a year, not a few are restored sufficiently to permit them to leave the hospital and resume their employment. Those who come from the scorching climate of the interior, where the daily temperature is from 90° to 100°, exhibit no ill effects from the change of 30°; but, on the contrary, appear the better for it.

The climate of San Francisco has the reputation of being rapidly exhaustive of nervous power. Men absorbed in business complain of discomfort and debility. They strain every nerve in the exciting pursuit of wealth, day after day and week after week keeping up the tension in the one direction from morning to night, supplying the fancied waste by stimulating draughts, recreating, if at all, in dissipation at unseasonable hours, and after all this wear and tear of the vital machine, they charge on the climate the natural and inevitable results of their own violation of the laws of Nature. So far from the climate being unfavorable in this respect, I think it can be safely averred, that there is no climate in the world which, with proper regard to hygienic laws, enables men to endure more toil of body and mind, and to resist more effectually the ordinary causes of disease, than that of San Francisco and of the coast in general, within the range of the ocean-winds.

CHOICE OF CLIMATE FOR CONSUMPTIVES.

In regard to the choice of climate for invalids coming from the Atlantic States and other regions, it is a great mistake to suppose that any one locality will suit all forms of disease or invalidism. Doubtless some general results can be established; but in their application many exceptions will present. The Winters are mild everywhere in California, except in the mountain regions. But they are milder in the south than elsewhere, and consumptives will therefore find in San Diego, Santa Barbara, Los Angeles, and other localities in the southern counties, the most desirable abode in Winter and early Spring. But in the Summer I believe the bay climate before described is not excelled in sanitary qualities by any other. In the advanced stages of pulmonary disease, it may be well for the patient, whose lease of life is but a question of

time, to select a location and there remain. But this is bad policy in the incipient stages, or when disease is merely threatened. Here the successful pursuit of health requires change and motion; and the best possible programme is to travel from place to place, from ocean to lake, in valley and on mountain, putting to the test the qualities of every location. The chances are, that by the time the health-seeker has determined the most salubrious spot, he will have regained his health.

Although nothing short of actual trial will determine the adaptation of climate or locality in a given case, yet we may often discriminate in regard to patients. Those having rheumatic or neuralgic complications should avoid the sea-board. So should those who are sensitive to cold, and whose hands and feet lose their temperature on slight exposure. On the contrary, when cold induces prompt reaction and has no chilling effect—when exposure induces a speedy glow of the surface—in other words, when there is an abundant supply of animal heat, the ocean climate is likely to be best adapted.

There are two opposite courses of hygienic treatment appropriate to consumptives—an outdoor life on the one hand, and housing and protection on the other. Up to a given point in the progress of each case the former is applicable; after that the latter. There is no proper medium. As soon as the patient ceases to be able to live almost wholly in the open air, domestic comfort must be diligently sought. In the ocean climate particularly, fire should be kindled on the hearth morning and evening.

ADVICE TO CONSUMPTIVES.

It is now a well-established principle in therapeutics, that an outdoor life, for those predisposed to phthisis, or in the incipient stage, is prophylactic and curative beyond any other course. Owing to the absence of rain for six months of the year, and the small number of rainy days in the other six months, California furnishes opportunities for carrying out this plan almost unrivaled in any other country.

"*Camping out*" is getting to be a common practice with invalids. A party is formed, and some mountain nook or other desirable spot is selected, where, with tents and simple bedding and cooking utensils, the company spend their time in fishing and hunting and recreation of all kinds; and if, happily, they are provided with the intellectual means, in the practical study of the charming Book of Nature. Not only do consumptives in the early stages of disease—in the early stages alone, however—encounter with safety the exposure, but they almost invariably improve in health and strength.

I regard this subject as of great importance, and well worthy of more attention than has hitherto been conceded to it by the profession. Having been applied to frequently by letter from the Atlantic States, and personally by visitors seeking a health resort on this coast, to escape from threatened pulmonary disorder, and having in former years recommended such applicants to towns and settlements in the interior or in the south, I have more recently adopted what has certainly proved to be a better course, and which is embodied in the following instructions:

"Set out and seek for yourself the place you want. If you are able to ride in the saddle, be sure and do so every day, wherever you are. Stop at a place only as long as your health improves. Buy a horse or a mule, mount him, and strike out through the country, over vale and mountain, on an exploring expedition. If the weather is hot, use the

early morning, and lay by from the hot sun, or for other good cause. Keep moving, up to the point of endurance. Eat anything your appetite craves. Accustom yourself to rough, wholesome fare. Drink all the milk you can, and if you can't get milk, drink cream. Avoid all spirituous and fermented drinks, especially if you have an appetite for food or milk. Always wear flannel next the skin. Never omit the daily worship of Cloacina."

RELATION OF PHTHISIS TO RACE AND NATIONALITY.

The mortuary statistics of San Francisco, as compiled by the Health Officer, Dr. Henry Gibbons, Jr., and published in his annual report, show five hundred and sixteen deaths from phthisis in the year ending June, eighteen hundred and seventy-five, exclusive of Chinese, from whom no authentic returns can be procured. Of this number there were: Born in California, fifty-two; born in the Atlantic States, one hundred and thirty; born in foreign countries, three hundred and thirty-two; unknown, two. That is to say, only one fourth of the decedents from phthisis were Americans, so called, for the fifty-two born in California were of the Spanish and Indian races. The proportion of American adults to foreigners, in the population of San Francisco, is about two to three, so that if the Americans had suffered from the disease as much as foreigners, the figures would stand thus: Deaths among Americans, one hundred and eighty-five; deaths among foreigners, two hundred and seventy-three. If we extend the inquiry, to ascertain what foreign nationality has suffered most, we shall find a remarkable disparity to the prejudice of the Irish race, which, with about one half the foreign population, furnishes two thirds of the deaths in that population. Though these results are not exact, yet I am confident that they are not far from the truth. I do not hesitate to assert that, in San Francisco, there is much less tendency to pulmonary consumption in the native Anglo-Saxon stock than in any of the foreign races. In hospital practice this is well marked, and in my own private practice it has been not less so. I have taken the pains to inquire among my brother practitioners, who very generally unite with me in the belief that *phthisis seldom originates in the climate of San Francisco among the American population.* A large proportion of the deaths of Americans have been of individuals who have left their Atlantic homes after the development of the disease.

But why should the Irish people suffer so fearfully from this cause? Not on account of poverty and want, for there is not a city in the world where the laboring classes are so well housed, so well clothed, and so well fed as in San Francisco. A large proportion of them own their homes, and enjoy the comforts and luxuries of life to a rare extent.

There is more reason for ascribing the prevalence of phthisis among the Irish people to the very opposite condition, namely, the change from the rugged and comparatively out-door life of their native country to the ease and indulgence of a higher civilization. It is a well-known fact that the aborigines of this coast, when transplanted from their wigwams to American homes, become sensitive and liable to disease, and their diseases tend to the lungs and are rapidly fatal. Again, it is observed that whilst the inhabitants of cities may plunge with im-

punity into the rugged life of the mining camp, a return from "roughing it" to the luxuries of a city home is fraught with danger.

In the estimation of some writers, the Irish, as a race, are prone to phthisis. Perhaps the tendency is increased by the very general habit of their females to indulge in strong drink. There is no nationality in which both sexes are so addicted to this practice; at least such was formerly the case, though a great and a blessed change is in progress among them, through the agency of their temperance associations.

I may be permitted another remark on this topic. If there were any prophylactic virtue in whisky as against phthisis, the Irish people ought to exhibit a marked exemption from that malady.

THE EPIZOOTICS OF 1873 AND 1875.

In 1873, and now again in 1875, an *equine influenza* marched across the continent from the Atlantic to the Pacific Ocean. In 1873 it approached in two directions—from Texas, through Arizona, on the south, and northward by the great route of travel through Utah and Nevada. In the present year it descended on this coast in an universal shower, without noticeable approaches. The only epidemic of which we have any knowledge as having crossed the continent previously, was the malignant cholera of 1850, which pursued nearly the same course as the epizoon of 1873, though less distinctly marked in its advance and less rapid in its march.

To those who regard the winds as the means of wafting the seeds of epidemic disease, a fact of some interest presents itself for consideration. At the time of the march of the horse plague over the Sierras and its precipitation on the western slope, a constant current of air was sweeping from the ocean in the direction exactly opposite. Not only did this great atmospheric wave occupy the lower stratum of air in contact with the earth's surface, but it extended upwards to the region of the cirrhus clouds, as their course from day to day demonstrated. Perhaps there is no point on the globe, in the region of population and civilization, where a deeper and more uninterrupted current of air sweeps in a more uniform course And it was in the teeth of this wave that the epizootic sped on swift wing across the Sierras, and from the mountains to the sea.

The epidemics under consideration derive a special interest from their evident relation to human health. For two years prior to 1873, our State had enjoyed a remarkable exemption from disease. But simultaneously with the accession of the horse influenza, or rather in anticipation of it, a general tendency to eruptive and contagious disorders was manifested, particularly among children. Measels, whooping-cough, and scarlatina were developed quite suddenly in all directions. For the first time on the Pacific Coast, cerebro-spinal meningitis appeared as an endemic, invading a few localities in the northern section of the State.

The relation of cattle plagues to human health is a question of great importance. Comparative anatomy and physiology have thrown much light on the anatomy and physiology of man; and it will scarcely be doubted that comparative pathology and epidemiology can be made to serve a similar useful purpose. The interests of medical science demand a complete history of the epidemics of 1873 and 1875, particularly the former, from some competent member of our profession in the Atlantic States, where the sources of information abound.